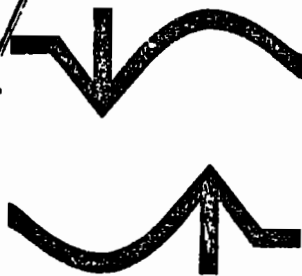


Norman C. Wauke, P.E.
VP

545 Indian Mound
Wayzata, Minnesota 55391
(612) 473-4224



PROPOSAL FOR

931305

US I.P.A. RECORDS CENTER REGION 5



514447

Consultant Services DRINKING WATER TREATMENT AND REMEDY EVALUATION



April 1980

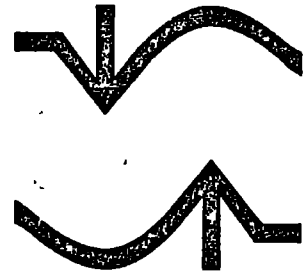


EUGENE A. HICKOK AND ASSOCIATES

002948

545 Indian Mound
Wayzata, Minnesota 55391

(612) 473-4224



April 11, 1980

Mr. Richard Koppy
Director of Public Works
City of St. Louis Park
5005 Minnetonka Boulevard
St. Louis Park, Minnesota 55416

Dear Mr. Koppy:

The firm of E. A. Hickok and Associates is pleased to present this formal proposal to provide professional engineering consulting services to the City of St. Louis Park. These services will provide the technical and economic information necessary to design and implement a carbon treatment process or other treatment process for one or more water wells to alleviate the chemical contamination from the drinking water. As you know, the firm has been selected to perform the investigation of the groundwater contamination problem for the Minnesota Department of Health. This project will be beginning within a few weeks and much of the information developed during that project is directly applicable to the project for the City. Many of the tasks required to perform your study are an extension of the tasks which will be under contract with the Minnesota Department of Health.

Where does HCPA come in?
For this project, we have associated with the engineering firm of Henningson, Durham and Richardson. Personnel from the firm of E. A. Hickok and Associates have designed approximately thirty water treatment and wastewater treatment plants for various municipalities within Minnesota. In addition, the firm of E. A. Hickok and Associates has performed research on filtration with activated carbon for the Environmental Protection Agency and have performed pilot plant testing for the drinking water supply of Wilkes-Barre/Scranton, Pennsylvania.

We believe that this team offers the City of St. Louis Park the strongest possible combination of consulting capabilities for this project. Nearly all the work to be performed on the project will be performed locally but the team will have access on an as-required basis to a wide spectrum of specialized expertise. This combination will be of significant benefit to the City of St. Louis Park and the project.

002949

Mr. Richard Koppy
Page Two
April 11, 1980

We appreciate this opportunity to offer our services to the City. We want to stress our interest and desire to be your consultant for this project. We are available, at your convenience, to discuss this proposal for a more in-depth interview.

Respectfully submitted,

EUGENE A. HICKOK AND ASSOCIATES

A handwritten signature in cursive script, appearing to read "E. A. Hickok".

Eugene A. Hickok, P.E.
President

crs

002950

PROPOSAL FOR
CONSULTANT SERVICES
DRINKING WATER TREATMENT AND REMEDY EVALUATION

PREPARED FOR
THE CITY OF ST. LOUIS PARK
ST. LOUIS PARK, MINNESOTA

PREPARED BY
EUGENE A. HICKOK AND ASSOCIATES
545 INDIAN MOUND
WAYZATA, MINNESOTA 55391

APRIL 1980

002951

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	PERSONNEL	3
III.	EXPERIENCE	6
IV.	WORK PLAN	9
V.	FACILITIES	16
VI.	REFERENCES	17

002952

INTRODUCTION

OBJECTIVES

*What about treatment
method other than
carbon?*

The objective of this project is to provide technical and economic information necessary to design and implement a carbon treatment process for one or more of the St. Louis Park water wells to alleviate or mitigate the chemical contamination from the drinking water supply. It is the intent to identify methods and procedures to allow the City to provide adequate water supply for the summer of 1980. It is anticipated that the carbon slurry treatment process which was used during 1979 will be continued on Well No. 15 during 1980. It is the intent to focus the treatment on Wells No. 10 and 15. It is the intent of the firm of E. A. Hickok and Associates to utilize as much of the information as possible that is developed for the project that is being performed for the Minnesota Department of Health. Much of the basic data collection, literature review and treatment levels are identified or will be identified in that project.

It is our intent to perform further study on the carbon treatment methods to determine the efficacy of treatment based on treatment method, contact time and chemical injection levels. Treatment costs will be developed and compared with other alternatives which will allow the City to regain capacity loss of wells. It is understood that the City will provide documentation on other alternatives including interconnection with other communities, reconstruction of the affected wells and dilution of contaminated water with uncontaminated water.

*Where is our
documentation?*

A sampling testing program will be designed and implemented during the course of the project and detailed cost estimates of the proposed treatment system will be presented in an engineering feasibility report. All of the cost will be identified, including the cost of design, capital expense, operating expense and maintenance expense. It is also the intent to assist City and State officials in the task of seeking financial aid in preparing the appropriate grant applications.

002953

INTRODUCTION

CAPABILITIES

The firm of E. A. Hickok and Associates is a multi-disciplinary firm of approximately forty persons, including professionals from the areas of civil engineering, sanitary engineering, groundwater hydrology, surface water hydrology, hydraulics, chemistry, microbiology and biology, applied physics, system analysis, computer science and mathematics. Personnel from the firm have performed projects of similar complexity and scope as well as projects of much larger scope. The multi-disciplinary aspect of the team provides a unique opportunity for the exchange of informational concepts, theories and hypotheses, and provides optimal final conclusions because of the diverse experience and background of the individual team members. The team members are more fully described in the following section as well as their appropriate experience. The detail on each of the persons is shown in the Technical Expertise at the end of the proposal.

EXPERIENCE

The firm of E. A. Hickok and Associates as well as members of the firm have a great deal of experience in the evaluation of water treatment methods. A number of pilot treatment projects have been performed on both drinking water and stormwater applications. A sophisticated and complex pilot scale testing plant was specified, set up and operated for the Pennsylvania Gas and Water Company in Wilkes-Barre/Scranton, Pennsylvania. Part of the evaluation procedure included the evaluation of activated carbon as a filter media. In addition, the firm of E. A. Hickok and Associates has performed a research and development project for the United States Environmental Protection Agency using granular activated carbon as a media in high-rate pressure filters to remove contaminants from water. Other pilot scale water treatment methods have been used, including biologically active soil filtration units standard sand filtration equipment, chemical treatment, ultraviolet and ozone treatment systems. Members of the firm have designed many water treatment systems and are familiar with the various treatment processes and costs, including design, capital, operating and maintenance. The firm has a great deal of experience in preparing grant applications and has a very high success ratio obtaining grants for various projects on both the federal and state levels of government.

The following section will detail the capabilities of the personnel of the firm proposed for this project with the following section highlighting the experience of the firm, followed by a section entitled, "Work Plan," which will detail our technical approach to the project.

PERSONNEL

Personnel to be assigned to this project are shown on the Project Organization Chart and are briefly described below.

Eugene A.
Hickok, P.E.

Mr. Eugene A. Hickok, P.E., will be the Principal-in-Charge and will have overall management responsibilities for the project. Mr. Hickok is also Principal-in-Charge of the concurrent project for the Minnesota Department of Health. Mr. Hickok has had more than 25 years of experience in evaluation of groundwater supplies for drinking water and has been associated with the St. Louis Park groundwater problem since the late 1960's.

George W.
Boyer, P.E.

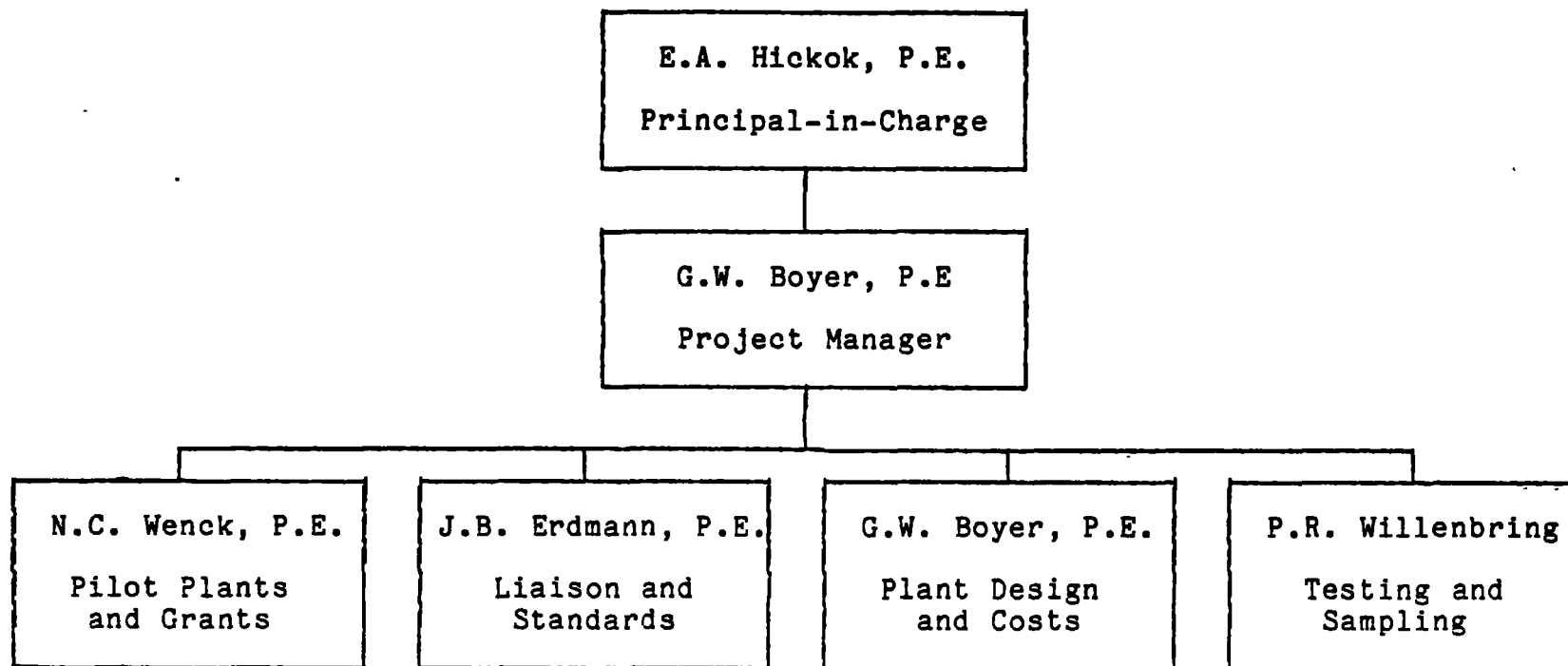
Mr. George W. Boyer, P.E., will be the Project Manager. Mr. Boyer has designed more than thirty major water and wastewater treatment plants in the States of Minnesota, Wisconsin and Iowa. He is an experienced designer of water supply, water treatment, waste treatment and general civil and municipal projects. He is an experienced specification writer and construction contract administrator. He has extensive experience in estimating construction costs and developing practical solutions to difficult problems. Mr. Boyer designed and managed an extensive pilot water treatment plan for the Pennsylvania Gas and Water Company in Wilkes-Barre, Pennsylvania. These pilot studies included the filtration with granular activated carbon media, as well as various chemical treatment methods.

Norman C.
Wenck, P.E.

Mr. Norman C. Wenck, P.E., will have responsibilities in the design and management of the pilot plant testing. Mr. Wenck has done extensive research in the field of water filtration using a number of techniques using multi-media filters, chemical additions, high rate granulated activated carbon filters and deep bed mixed media filters. Mr. Wenck was in responsible charge of the high-rate filtration research performed for the Environmental Protection Agency and has a working knowledge of pilot testing facilities. Mr. Wenck is familiar with the United States Environmental Protection Agency construction and research and development grants process and has successfully prepared several major grant applications for communities within Minnesota.

002955

PROJECT ORGANIZATION CHART



002956

PERSONNEL

John B.
Erdmann, P.E.

Mr. John B. Erdmann, P.E., will serve as liaison with the Minnesota Department of Health project, since he is the Team Leader for that project. Mr. Erdmann will be instrumental in the exchange of information between the two projects. He will be responsible for the literature review areas as well as the standards setting task. Mr. Erdmann's experience includes development of standards for the handling and disposal of hazardous wastes for the Iowa Department of Environmental Quality and has a working knowledge of the state and federal standards for drinking water and groundwater standards.

Peter R.
Willenbring

Mr. Peter Willenbring is a civil engineer with an extensive background in the sampling of water and wastewater. Mr. Willenbring was previously employed by the Minneapolis office of the Environmental Protection Agency. He was in responsible charge of surveillance and compliance monitoring of various industrial waste dischargers. In addition, Mr. Willenbring is familiar with water treatment processes and will provide the expertise on sample collection, sample handling and sample preservation, as well as data analysis from the pilot testing.

The firm of E. A. Hickok and Associates will use selected personnel from the firm of Henningson, Durham and Richardson, which is an associated firm on the Minnesota Department of Health project. In addition, other support personnel from the firm of E. A. Hickok and Associates are available and these people are detailed in the last section of this proposal entitled, "Technical Expertise."

002957

EXPERIENCE

PILOT PLANT TESTING AND DRINKING WATER TREATMENT EVALUATION

Client: Pennsylvania Gas and Water Company

A comprehensive evaluation and investigation of drinking water treatment parameters for a surface and groundwater supply for the Pennsylvania Gas and Water Company was performed using a "Water Boy"-type pilot plant. More than 100 independent runs were performed to evaluate chemical type, chemical usage, optimum filtration rate, optimum filter media and the requirement for various intermediate processes. The results of the pilot testing provided the basic design data with which to evaluate various alternatives of treatment of water for this municipal water supply. Finally, a 16 million gallon per day plant was designed to meet the requirements of the Drinking Water Act.

HIGH RATE GRANULAR ACTIVATED CARBON PILOT TESTING

Client: The U.S. Environmental Protection Agency

A three column granular activated carbon high-rate filtration pilot plant unit was designed and constructed for the U.S. Environmental Protection Agency. This unit was operated during two seasons to define the operating characteristics of various combinations and sizes of granular activated carbon media and the maximum flow rates that could be achieved and yet produce an acceptable quality of water. The operating experience gained from this project will be very valuable to the performance of the pilot testing proposed for the City of St. Louis Park.

WATER TREATMENT PLANT DESIGNS

Clients: Cities of Worthington, New Ulm and
Luverne, Minnesota

Water treatment plants, including chemical precipitation and filtration were designed for the above communities with capacities of plants varying from 1 million gallons per day to more than 4 million gallons per day. Many of these systems included a complex system of groundwater supply from a number of wells; in some cases several miles from the water treatment plant, while others required a complex control system due to the variability of quality of the raw water. Design and estimating experience have been gained through the design and construction of these facilities.

002958

EXPERIENCE

SEEPAGE POND IMPACT STUDY

Client: Minnesota Pollution Control Agency

The study evaluated the impact of seepage from wastewater stabilization pond systems on groundwater and surface water quality. Existing systems, which characterized the general geomorphic regions of the state were evaluated. The effectiveness of the seal, the effects of the bottom deposits and the significance of the underlying soils were determined and evaluated. Complete water and nutrient balances were developed for each system. Intensive groundwater sampling and level monitoring programs were implemented, climatological data was collected and bacteriological and chemical water quality monitoring programs were established to define the variables of each system.

SOIL RENOVATION OF WASTEWATER AND IMPACTS ON GROUNDWATER

Client: City of Balsam Lake, Wisconsin

This comprehensive hydrological evaluation of a proposed wastewater adsorption system considered a variety of factors including groundwater flow, quality and fluctuations, permeability and adsorptive capacity of the soils systems, impact of wetlands on effluent quality and groundwater quality and effects of soils on the nitrogen, phosphorus and heavy metals concentrations. This evaluation permitted approval of a system based on several recommended design modifications.

GROUNDWATER MONITORING

Client: Eagle-Picher Industries, Inc.

In order to determine the presence or absence of groundwater pollution from old mines, a groundwater quality monitoring program was established. The firm also conducted field investigations of all wells in the area and all mine shafts. The firm researched and evaluated historical data, determined historical groundwater tables and estimated historical water quality.

WASTEWATER POND SEEPAGE

Client: Minnesota Department of Natural Resources

The wastewater treatment facility for Itasca State Park was evaluated to determine the impact of seepage from the pond system on the water resources of the Mississippi headwaters area. This study evaluated the groundwater and surface water quality by performing water and nutrient balances for the system. Intensive groundwater and sampling and level monitoring programs were used along with climatological data, bacteriological and chemical water quality information to define the operating regimes in the system.

002959

EXPERIENCE

GROUNDWATER PROTECTION PROJECT

Client: Wisconsin Paper Mills

A potential groundwater pollution problem occurred by the storing of sulfite liquor waste in lagoons from which seepage was able to enter an important groundwater system. A system of barrier wells was designed and constructed and have successfully contained the contaminant plume for more than twenty years. This most important and successful projects has shown that important water resources can be protected from toxic and hazardous wastes.

HAZARDOUS AND TOXIC CHEMICAL EVALUATION

Client: Iowa Department of Environmental Quality

The project defined the extent of an industrial waste disposal site which was used for potentially hazardous and toxic chemicals for over 25 years. A regional aquifer system is potentially threatened by the waste site and alternative actions to protect the environment were evaluated. Field borings, laboratory analyses for heavy metals and organic compounds were performed and mass balances developed for the four sites investigated. Fourteen comprehensive reports were prepared on a very rigid time schedule during a five-month period. Outputs include recommendation for safe disposal, recommended monitoring procedures and systems, recommended land disposal evaluation criteria, literature reviews as well as various interim reports.

HAZARDOUS WASTE IMPACTS ON GROUNDWATER

Client: Metropolitan Waste Control Commission

A comprehensive review and evaluation of available computer groundwater models was performed. The model was applied to a planned hazardous waste site for the environmental and field evaluation studies. The model can be used to predict the direction and rate of movement of leachate which might escape a chemical landfill and to evaluate various remedial actions. Two models were tested and verified and the recommended model was revised for the specific project and tests on a hypothetical site were performed. A sensitivity analysis was performed to determine the level of field data that is required for the desired results. Factors such as solute transport, density and dispersion effects, complete anisotropy, heterogeneity, recharge rate, vertical and horizontal hydraulic conductivity, porosity, geomorphology and leachate quality were evaluated.

002960

WORK PLAN

INTRODUCTION

A review of the Request for Proposal indicates that the Consultant is to provide technical and economic information necessary to design, implement a carbon treatment process for one or more wells and alleviate chemical contamination of the drinking water. It is understood that the Consultant will be required to perform further study on the carbon treatment method to determine the efficacy of treatment based on treatment methods and chemical injection levels. Costs are to be compared with other alternatives which will allow the City of St. Louis Park to regain the capacity lost of wells temporarily closed due to the contamination problem. A sampling and testing program will be designed to be included with the treatment program during periods of operation. It is understood that the Consultant will be required to prepare detailed cost estimates of the proposed treatment systems and in addition, will provide an engineering feasibility report to be submitted to the City Council. In addition, it is understood that the Consultant will assist City and State officials in the task of seeking financial aid from various federal and other sources.

Our general approach to any project is to collect and evaluate all available data before proceeding to the project. The firm and associated firms will be working concurrently on a project with the Minnesota Department of Health with many of the tasks outlined to be parallel and it is the intent to use much of the data developed in the Minnesota Department of Health project for the City's work.

Project management is a key to the successful and prompt completion of any project. The program outlined in this proposal, though not all-inclusive, is anticipated to contain the bulk of the final work plan. Final refinement of the program will be accomplished during negotiations with the City of St. Louis Park. The entire project will be planned and programmed to ensure that manpower, equipment and other requirements can be brought together in the proper timing to accomplish program objectives within the time and fiscal framework. The firm views this project as a major project in developing the body of knowledge related to the treatment of drinking water when contaminated by carcinogenic agents. Our technical approach to this project has been divided into seven major tasks. These tasks will be briefly described in the following paragraphs.

002961

WORK PLAN

- Task 1 -**
Review Earlier Studies and Results and Identify Alternative Methods of Treatment
- It is the intent of this task to utilize both information and data developed from the Minnesota Department of Health project and additional effort as detailed below. The review of the pilot plant studies which were implemented by the City of St. Louis Park and the Minnesota Department of Health during 1979 will be performed. Specific methods of activated carbon treatment will be reviewed. A search for data will be made in the literature using various techniques with the same or similar types of contaminants present in some of the St. Louis Park wells. It is anticipated that in addition to the carbon slurry treatment, granular activated carbon filters will be available for use and that certain chemical additions such as ozone or treatment with ultraviolet light may be effective in neutralizing or removing the contaminants present in some of the wells. Only those systems that are identified as having potential to be successful in mitigating the contaminants present in the drinking water will be studied further.
- Task 2 -**
Design and Supervise Treatment Testing Program
- Those methods that have been identified as having a reasonable chance of success and where equipment is available will be evaluated for further pilot testing. A pilot testing program will be designed for all the techniques that are reasonably available to be studied. It appears that the granulated activated carbon filters presently owned by the Minnehaha Creek Watershed District would be available for pilot testing; however, new media and some maintenance work would be required to bring these filters into operating status. Various contact times, flow rates, chemical addition rates and other parameters would be determined and a test and sampling program would be developed. It is anticipated that the planned carbon slurry pilot treatment work that is scheduled for 1980 would be coordinated with the additional efforts and that much of the sampling that would be required would be performed under that program. Additional laboratory analyses are planned and are shown in Table 1, Estimated Project Budget. The sampling and testing program will be designed to determine the effectiveness and reliability of the treatment process or processes.

002962

WORK PLAN

- Task 3 - From the pilot testing results, the treatment process' operating characteristics can be developed. In addition, design parameters will be developed for the optimum treatment processes. The degree of protection afforded by each of the alternatives will also be determined.
- Develop
Treatment
Process
Operating
Characteristics
- Task 4 - In addition to the development of treatment process cost, the review of the cost to implement other alternatives, which will be developed by the City, will be performed in this task. The costs that will be developed by the City for the other alternatives including interconnection with other communities, reconstruction of affected wells and dilution of contaminated water with uncontaminated water will be analyzed, and if these estimates are reasonable, will be compared with the treatment process costs identified in this task.
- Develop
Treatment
Process Cost
for Design,
Capital
Investment,
Operating
Expense and
Maintenance
Expense
- Task 5 - An engineering feasibility report will be prepared documenting the work performed under this project. The report will include the cost of implementing the various alternatives, the degree of protection afforded by the alternatives against future well closures, documentaion of the levels of treatment realized in comparison with the quantities of chemicals utilized, the equipment and plant facilities necessary to obtain a specific level or method of treatment, documentation of the estimated operating characteristics and the cost of the treatment system or other alternatives. In addition, the feasibility report will contain the number of wells to be treated, the detailed engineering design consultant costs, the construction costs, the estimated operating costs of the system and, of course, the recommended course of action that the City should take based on the results of this study. During the preparation of this feasibility report, close liaison will be maintained between the City of St. Louis Park and the Minnesota Department of Health and other agencies involved with this overall situation.
- Preparation
of an
Engineering
Feasibility
Report

002963

WORK PLAN

- Task 6 - Explore and Assist with Potential Grants
- It appears that financial assistance for the implementation of a drinking water treatment system may be available. A search for potential grants for this project will be made and assistance in the preparation of the grant will be provided. In recent correspondence with the U.S. Environmental Protection Agency, it became clear that this type of project may receive a very high priority for funding from the EPA. A plan of action is presently being formulated and will be presented to the City as soon as work on this project is authorized.
- Task 7 - Interaction
- This most important task will include interaction between the members of the Consultant Team with City officials and staff, the Minnesota Health Department, members of the St. Louis Park City Council and other agencies that are involved with this problem. It is visualized that a monthly progress report will be submitted to the Director of Public Works and that if desired, a short presentation of the progress of the project can be made to the Director of Public Works and other staff or officials that may be interested in the project.

002964

WORK PLAN

ESTIMATED PROJECT BUDGET

The estimated project budget for the work as described in this proposal is shown on Table 1. The budget includes the seven tasks with the number of hours for categories of employees plus the expenses that may be incurred for this project. It should be noted that personnel from the firm of Henningson, Durham and Richardson and Geraghty and Miller are both available to participate in this project and will be used in whatever manner necessary. This project budget is viewed as preliminary in nature and during negotiations with the City, changes to the basic work plan would necessarily result in a changed allocation of man-hours and expenses. An opportunity to discuss the possible modifications will be appreciated.

PROJECT SCHEDULE

The proposed project schedule is shown on Figure 1. Assuming that the project can be initiated by May 1, 1980, the pilot testing program would be complete by the end of the summer, with the feasibility report submitted to the City by the end of November. Again, it should be noted that this schedule is somewhat flexible, depending on the needs of the City, but that to optimize the use of information flow from the Minnesota Department of Health project, this schedule appears to be making use of a reasonable amount of interaction and yet provides the final product in a reasonably short amount of time. Again, this schedule is subject to review and modification during contract negotiations.

002965

FIGURE 1

PROPOSED PROJECT SCHEDULE

[illegible]

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TABLE 1
ESTIMATED BUDGET FOR
CITY OF ST. LOUIS PARK
DRINKING WATER TREATMENT PROJECT

<u>TASK</u>	<u>Principal</u>	<u>Program Manager</u>	<u>Engineer</u>	<u>Labor Expense</u>	<u>Laboratory Expense</u>
I. Review earlier study and results and identify alternative method of treatment	4	8	40	\$ 1,928	
II. Design and supervise treatment testing program		66	86	5,318	\$1,500
III. Develop treatment process operating characteristics		16	36	1,668	
IV. Develop treatment process costs (design, capital operating estimate)		48	64	3,864	
V. Prepare an engineering feasibility report		64	48	6,488	
VI. Explore and assist with potential grants	4	24		1,376	
VII. Interaction	16	40		<u>2,816</u>	<u> </u>
				\$23,458	\$1,500

002967

FACILITIES

FACILITIES

E. A. Hickok and Associates is located in Wayzata, Minnesota, just fifteen minutes from downtown Minneapolis. The firm is housed in two-two story buildings with an adjacent laboratory just a short distance from Lake Minnetonka.

FIELD EQUIPMENT AVAILABLE

The firm has equipment available to do all types of field monitoring and surveying. E. A. Hickok and Associates owns three boats of various types and styles to provide mobility in sampling in nearly all types of surface water environments. The firm has a wide range of manual and automatic sampling equipment for monitoring surface waters. It also has dredge equipment for monitoring and sampling of bottom sediments. It also has flow measurement capability with over thirty flow monitoring units and several manual monitoring systems. The firm also has a complete meteorological monitoring station, including evaporation. The firm has geophysical measurement equipment, including seismic and resistivity units. E. A. Hickok and Associates also has surveying and soil and sediment analysis equipment.

LABORATORY EQUIPMENT

The firm has a complete water quality laboratory specializing in trace metals and microbiological analysis. E. A. Hickok and Associates owns both a flame and furnace atomic absorption unit as well as an ultraviolet visible spectrophotometer.

LIBRARY

The firm of E. A. Hickok and Associates has its own private library with over 1,500 volumes and receives numerous periodicals in the areas of engineering and environmental science. The firm's offices are adjacent to the Hennepin County Public Library, which has access to an inter-library loan system. The firm also has easy access to the Ecol Library, which is part of the Minneapolis Public Library System, and also the Wilson Library at the University of Minnesota.

WORD PROCESSING

The firm has one of the most advanced word processing systems in the nation, with two electronic word processing units which use CRT display along with a computer disk system, which allows easy programming and access of material for editing and display.

PILOT SCALE WATER TREATMENT EQUIPMENT

The firm has designed and used for two seasons three GAC high rate filters to evaluate the effectiveness of removing trace contaminants from water. Various flow rates, chemical additions and filter media can be evaluated.

002968

REFERENCES

References for E. A. Hickok and Associates

Mike Schultz (712-736-2385)
Osceola County Rural Water System
Melvin, Iowa 51350

Mr. Charlie Miller (515-281-8151)
Iowa Department of Environmental Quality
Henry A. Wallace Building
Des Moines, Iowa 50314

Mr. Tom Morrow, P.E. (202-426-3826)
Federal Aviation Administration
800 Independence Avenue S.W.
Washington, D.C. 20591

Mr. Lanny Peissig (612-296-7397)
Minnesota Pollution Control Agency

Mr. George V. Dimke (612-784-7669)
Rice Creek Watershed District
Suite 177 - Arden Plaza
3585 Lexington Avenue North
Arden Hills, Minnesota 55112

Mr. David H. Cochran (612-733-2177)
Minnehaha Creek Watershed District
4640 Linwood Circle
Excelsior, Minnesota 55331

Mr. William B. Olson (612-926-5782)
Metropolitan Airports Commission
6040-28th Avenue South
Minneapolis, Minnesota 55450

002969

TECHNICAL EXPERTISE
EUGENE A. HICKOK AND ASSOCIATES

002970

GENERAL DESCRIPTION

The firm of E. A. Hickok and Associates is a leading firm of consultants on water and waste problems in the Midwest. The firm has a broad interdisciplinary staff of professionals in such fields as hydrology, geology, civil and sanitary engineering and computer applications. The company also operates a comprehensive biological, bacteriological and chemical laboratory to provide expert analysis of soil and water samples.

Principals of the firm have authored numerous water resources reports which have been published by government agencies and professional journals. The company has received various awards for its work in water resources. In 1971 for example, it won state and national awards from the Consulting Engineers Council of the United States for the Overall Plan for the Minnehaha Creek Watershed District. The District is the largest in the Twin Cities Metropolitan Area, and includes 27 municipalities and 184 square miles.

The company has provided professional services on water quality to the World Health Organization, the Pan American Health Organization, and many federal and state agencies and local governments. The company has also provided hydrologic services, including wastewater treatment recommendation, to many clients in the following industries: paper, power, mining, food processing, chemical manufacturing, heavy equipment manufacturing, oil, textile and brewing.

The company is a leader in the application of computers to water management. The firm has also furnished expert testimony in several states in litigation involving water issues.

E. A. Hickok and Associates is capable of complete problem solving services; from identifying the problem, through evaluation, planning and design of alternative solutions, to the implementation of the solution.

002971

E. A. Hickok and Associates is known for its ability to get the project done on time and on budget. The project approach to projects is utilized whereby a project manager is responsible for scheduling and budgeting. The entire staff is then open to him for technical expertise. This enables each client to benefit from the staff's diversity. The remainder of this brochure provides a description of E. A. Hickok and Associates by cross-sections of its projects, clients, personnel and facilities.

SCOPE OF WORK

Water Quality Monitoring Programs have been established for many governmental clients in order to measure various chemicals and biological factors, evaluate water quality and determine the input and impact from pollutional sources.

Limnological Studies have been conducted to quantify the nutrient balance for lake systems. In this connection, management guide lines have been prepared to assist governing bodies in improving the quality of their water resources and in helping to restore the ecological balance.

Water Treatment Systems have been designed by the firm for the removal of turbidity, iron and manganese and for softening, chlorination, fluoridation and de-ionization of water supplies of both municipalities and private industries. Investigations to increase the efficiency of water treatment facilities have also produced savings for many clients and helped to conserve water resources.

Water Systems providing ultra-pure water for special applications such as plating, etching and cleaning processes have been designed for numerous industrial clients. The re-use of cooling water and other methods of water conservation recommended by the company have resulted in reduced water costs.

Solid Waste Disposal Plans have been prepared to provide environmentally acceptable solutions for the ultimate disposal of solid wastes. Careful consideration is given in these studies to runoff factors, leaching effects, geologic formations and groundwater.

Artificial Recharging of Aquifers has been evaluated for municipalities and industries whose existing groundwater supplies have become inadequate. The firm has investigated the merits of storing treated fresh water or de-mineralized brackish water in natural, underground reservoirs.

Contamination of Groundwater Supplies is an increasingly critical problem in both urban and industrial areas. The firm has conducted investigations to determine the sources of such contamination, along with patterns of movement and rates of flow, and this has resulted in appropriate abatement facilities and practices.

Regional Sewer and Water Planning is another environmental service in which the company is engaged. Water and waste system plans are integrated on an area-wide basis to accommodate projected urban growth patterns.

Comprehensive Water Quality Management Plans are extensive programs that involve safeguarding all aspects of water resources. Coordinated studies are undertaken of stormwater, groundwater, lakes and streams, limnology, waste treatment and rural as well as urban land use effects.

A Testing Laboratory is operated by the firm to provide complete analysis of water, wastewater, air soils and minerals. The technical significance of chemical and biological determinations is evaluated and reported in this laboratory. The detection and identification of iron bacteria and sulfate-reducing bacteria is one of the many special services which are made possible through maintenance of this facility.

Environmental Impact Studies have been prepared to evaluate the effect of projects or plans on the total environment. These studies involve quantification of the positive as well as the negative impact of a proposed project as well as the cost benefit analysis.

Flood Plain Studies have been performed to identify the flood plains and flood hazard zones of several rivers and streams for planning and management purposes.

Load Allocation Studies have been performed on eight river segments in the State of Minnesota. A mathematical computer model has been developed and used to solve the complex problem involved with multiple waste loads discharged to a stream or river.

Stormwater Treatment Facilities for major shopping centers, airports and other point sources have been designed to comply with the requirements of regulatory agencies. Control and management of stormwater runoff is becoming an increasingly important environmental aspect and must be considered during the initial planning process for any new facility or development.

Wastewater Treatment Systems have been designed by the firm including several with high industrial loads. In addition to conventional treatment processes, systems utilizing land application techniques have been designed and are operating. The recycling aspect of land application as well as increased crop production have made this technique an attractive alternative.

Research and Demonstration Studies have been performed under EPA Grant No. S-802535 to evaluate various methods of stormwater treatment. The evaluation of urban stormwater quality, the effectiveness of marshes and the effectiveness of high rate filtration and organic soil filtration were determined.

TECHNICAL EXPERTISE

TYPICAL PROJECTS

PROJECT DESCRIPTIONS

The following listing provides a cross-section of the types of projects undertaken by the firm. The staff is qualified in all these areas of expertise and more.

WATER QUALITY MONITORING PROGRAMS

Comprehensive programs of sampling, testing, evaluating and presenting water quality data, including chemical, physical and biological characteristics. The programs range in scope from a single wetland to a state-wide program. They are used to determine the impact of pollution sources and the effects of pollution abatement.

LIMNOLOGICAL STUDIES

Studies conducted to quantify the nutrient balance of lake systems. They are usually accompanied by management guidelines to assist in improving water quality and restoring ecological balance.

Pavement Friction Survey
Geologic Studies, Soil Testing
Monitoring, Limnological, Load
Allocation, Testing
Flood Control, Flood Plain Studies
Water Quality Management Plans,
Regional Sewer and Water Plans
Environmental Impact Studies
Aquifer Recharge, Groundwater Supply,
Groundwater Contamination, Groundwater
Depletion
Research and Development
Water Treatment Systems, Water Supply
Wastewater Treatment, Solid Waste
Disposal, Stormwater Treatment

002976

GROUNDWATER EVALUATIONS

GROUNDWATER
POLLUTION
INVESTIGATIONClient: Eagle-Picher Industries, Inc.

In order to determine the presence of absence of groundwater pollution from old mines, a groundwater quality monitoring program was established. The firm also conducted field investigations of all wells in the area and all mine shafts. The firm researched and evaluated historical data, determined historical groundwater tables and estimated historical water quality.

GROUNDWATER MODEL

Client: Metropolitan Waste Control Commission

A comprehensive review and evaluation of available computer groundwater models was performed. The model was applied to a planned hazardous waste site for the environmental and field evaluation studies. The model can be used to predict the direction and rate of movement of leachate which might escape a chemical landfill and to evaluate various remedial actions. Two models were tested and verified and the recommended model was revised for the specific project and tests on a hypothetical site were performed. A sensitivity analysis was performed to determine the level of field data that is required for the desired results. Factors such as solute transport, density and dispersion effects, complete anisotropy, heterogeneity, recharge rate, vertical and horizontal hydraulic conductivity, porosity, geomorphology and leachate quality were evaluated.

GROUNDWATER
PROTECTION
PROJECTClient: Wisconsin Paper Mills

A potential groundwater pollution problem occurred by the storing of sulfite liquor waste in lagoons from which seepage was able to enter an important groundwater system. A system of barrier wells was designed and constructed and have successfully contained the contaminant plume for more than twenty years. This most important and successful project has shown that important water resources can be protected from toxic and hazardous wastes.

002977

SOLID WASTE FACILITIES

ENVIRONMENTAL
IMPACT STATEMENT,
SANITARY LANDFILLClient: Washington County, Minnesota

A comprehensive analysis of the impact of a proposed landfill to serve a substantial portion of Ramsey and Washington Counties. The analysis included the groundwater, hydrology, geology, pollution potential, monitoring requirements and future land use.

SANITARY LANDFILL
IMPACTSClient: Holtz-Krause Sanitary Landfill,
Wausau, Wisconsin

A detailed evaluation of the operational plans and surface and groundwater systems was performed for this landfill located in the center of an urban area. Protection of both the surface and groundwater were of utmost importance because of the intensive use of these water resources. Operational procedures were developed and a complex groundwater monitoring program was designed and implemented to define and monitor the impacts of the operation.

SANITARY LANDFILL
EVALUATIONClient: Minnesota Department of Transportation

A comprehensive evaluation of a closed sanitary and demolition landfill was evaluated for the Minnesota Department of Transportation. The entire contents of this landfill, which had been closed for a number of years, were required to be moved to make way for a planned freeway system. A groundwater monitoring program was designed and implemented and was used to evaluate the effect of the excavation of the landfill. Disposal of the leachate and monitoring of the leachate present in this site were supervised by the firm.

MAJOR SANITARY
LANDFILL DESIGNClient: Washington County, Minnesota

A major metropolitan area sanitary landfill was designed and taken through the permitting process for Washington County for a new landfill. The design of this landfill had many unique features including a double clay barrier and double leachate with removal and control system. This engineered facility was a first-of-its-kind proposed in the State of Minnesota and has become an accepted standard for the design of this type of facility in the geologic setting proposed for that site.

002978

LIME SLUDGE
DISPOSALClient: Pennsylvania Gas and Water Company

A comprehensive investigation and site selection process was performed to define and evaluate sites for disposal of lime sludge from a variety of water treatment plants. The water treatment plants serve more than 450,000 residents of the metropolitan Wilkes-Barre/Scranton area. The assessment included the evaluation of numerous sites and the detailed groundwater monitoring of sites to determine the potential impact of disposing lime sludge at given sites on a long-term basis.

WATER MANAGEMENT PLANS

COMPREHENSIVE
WATER QUALITY
MANAGEMENT PLANClient: Dickinson County, Iowa

Under an Environmental Protection Agency grant to investigate pollution into the major chain of lakes in Iowa, E. A. Hickok and Associates directed a comprehensive regional investigation by 25 government agencies and three private associations of all factors affecting water quality. This \$155,000 program encompassed extensive water quality monitoring, groundwater studies, ecological evaluations, evaluations of historical data, hydrologic calculations, identification of pollution sources, quantification of waste inputs, studies of lake bottom sediments, recreational water uses, computer applications, existing and projected land uses, projected lake conditions, agricultural runoff, lakeshore property values, administrative policies and organization and a program of recommended improvement facilities.

BASIN WATER QUALITY
MANAGEMENT PLANClient: Iowa Department of Environmental
Quality

A comprehensive inventory and analysis of all municipal, industrial, semi-public, agricultural and non-point sources was prepared. Treatment needs were determined relative to water quality standards, load allocations and costs and priority of the needs were assessed. The analysis included the geology, hydrology, groundwater, growth projections and water quality.

WATERSHED DISTRICT
OVERALL MANAGEMENT
PLANClient: Minnehaha Creek Watershed District

An overall plan for the purpose of implementing a land, soil and water management program in a district comprising 17¹/₄ square miles was developed and includes both urban and rural areas. Present and future population densities and land-use requirements were major factors which had to be considered in the development of this plan.

TECHNICAL EXPERTISE**TYPICAL PROJECTS**

**ENGINEERING
MANAGEMENT OF
WATERSHED DISTRICT**

Client: Rice Creek Watershed District

Engineering management services for the Rice Creek Watershed District, which encompasses 201 square miles in Anoka, Hennepin, Ramsey and Washington Counties, are provided on an on-going consultancy basis. The Watershed District provides a local organization which coordinates all water management decisions in the watershed. In addition, local people are provided with legal and financial authority with which to act upon locally initiated projects aimed at solution to water problems.

002981

HAZARDOUS WASTE EVALUATION

MINNESOTA CHEMICAL
LANDFILL PROJECT

Client: Metropolitan Waste Control
Commission

This five year project funded by the United States Environmental Protection Agency is estimated to cost more than five million dollars over the project period. The project is designed to demonstrate land disposal techniques for potentially hazardous chemical wastes. The project emphasizes a high degree of citizen participation in the decision-making process and a high level of industrial awareness.

EVALUATION OF
HAZARDOUS WASTE
DISPOSAL

Client: Iowa Department of Environmental
Quality

The project defined the extent of an industrial waste disposal site which was used for potentially hazardous and toxic chemical for over twenty five years. A regional aquifer system is potentially threatened by the waste site and alternative actions to protect the environment were evaluated. Field borings, laboratory analyses for heavy metals and organic compounds were performed and mass balances developed for the four sites investigated. Fourteen comprehensive reports were prepared on a very rigid time schedule during a five-month period. Outputs include recommendation for safe disposal, recommended monitoring procedures and systems, recommended land disposal evaluation criteria, literature reviews as well as various interim reports.

002982

ENVIRONMENTAL INVENTORY AND ASSESSMENT

ENVIRONMENTAL
IMPACT ASSESSMENT
REPORTClient: Metropolitan Airports Commission

An environmental impact assessment report was prepared for a facility proposed to be constructed in an extremely sensitive habitat within the Minnesota River Valley and Fort Snelling State Park. Several alternatives and mitigative measures were required to obtain approval of this facility. A comprehensive and detailed inventory of the vegetation in the upland, the wetlands and the wildlife in the uplands, the pond and the wetlands was performed. The interaction between these factors and the park's objectives, the disturbances that would take place during construction and the operating conditions were assessed and quantified.

ENVIRONMENTAL
BASELINE INVENTORYClient: Metropolitan Waste Control
Commission

The firm was the prime consultant in an intensive effort to develop a detailed inventory and assessment of the ecological, social, cultural, physical and aesthetic characteristics of the seven county metropolitan area. The purpose of the project was to provide a baseline data source for the Metropolitan Waste Control Commission's on-going 201 Facilities Plan. The work involved research compilation and consolidation of existing data, updating when possible and providing additional sources of information. In addition to overall project management, Hickok and Associates performed detailed analyses in the discipline of climatology, topography, geology, geomorphology, soils hydrology, wetlands, water use, water quality, land-water interfaces, agriculture, land quality and environmental constraints. The documentation was designed to be used as a tool for the on-going planning projects for the Commission and other agencies in the Metropolitan Area.

WATER RESOURCES
INVENTORY PROGRAMClient: Minnesota State Planning Agency

Assemblage of all hydrologic data for the entire state, including the Upper Mississippi River Basin for reproduction in a report of the State Planning Agency.

002983

WATER QUALITY SURVEY AND MANAGEMENT

LOAD ALLOCATION
STUDIES

Client: Minnesota Pollution Control Agency

Load allocations for point sources were determined for eight river segments in the State of Minnesota. The studies included comprehensive stream surveys, including biological assessment, water quality and physical assessment of the streams. Hydrologic analyses of the basins were performed to determine the critical flows. Detailed documentation of the data and mathematical computer model are included in the final reports.

SURFACE WATER
QUALITY MONITORING
PROGRAM

Client: Metropolitan Council of the Twin Cities

A comprehensive survey of surface water quality was undertaken with special emphasis on defining the impact of stormwater and thermal discharges.

A monitoring program was established throughout a metropolitan area of 3,000 square miles, consisting of 148 sub-watersheds. Water samples were collected and analyzed from selected sub-watershed locations and from 52 lakes found within the area. Factors influencing water quality were identified. Through the use of a computer program, correlations were developed between water quality and land use classifications, soil types, slope and population densities.

RIVER POLLUTION
MONITORING PROGRAM

Client: Twin City Metropolitan Airports Commission

A water quality monitoring program was established to measure the polluttional effects of fuel spills. The water sampling network for this program extended approximately 30 miles down the Mississippi River from the airport facility.

When 150,000 gallons of aviation fuel were accidentally spilled into the Minnesota River from the airport, E. A. Hickok and Associates coordinated the cleanup activities.

RECREATIONAL FACILITIES

LAND AND WATER
MANAGEMENT
IMPROVEMENTS

Client: Minnehaha Creek Watershed District

A comprehensive and multi-faceted program consisting of thirteen separate recreationally oriented projects have been developed and designed for six cooperating units of government within the Minnehaha Creek Watershed District. The projects include a dam site recreation area, canoe landings, pedestrian trails and facilities, creek bed maintenance, kiosks, nature areas and landscaping of sensitive areas. The improvements were successfully tailored to match and meet the diverse requirements of the various government units and the concerned citizens. The public participation, coordination and support from the inception to the completion of this project has been a highlight.

RECREATIONAL
FACILITIES

Client: Okabena-Ocheda Watershed District
Worthington, Minnesota

A recreational facility was designed for water oriented facilities including boating, camping, picnicking, fishing and hiking. This rustic facility was designed to complement an artificial lake created to improve the water resources of this water deficient region. These facilities were designed with an expandability feature to ensure adequate facilities as the use and demand increases. Coordination with state, regional and local agencies was required to ensure compliance with the objectives of each agency.

002985

MUNICIPAL FACILITIES

MUNICIPAL WATER
SUPPLYClient: City of Worthington, Minnesota

The firm was involved in locating and developing groundwater sources for Worthington, whose future growth was threatened by an inadequate water supply. As a part of the immediate problem, the construction of a large food processing plant was being delayed until a reliable water supply could be assured. Electrical resistivity studies were made of large areas in and around the city. Quantitative hydrologic tests provided a dependable source of water seven miles from the city. Subsequently, production wells were drilled, a pipeline constructed and treatment facilities provided.

ASSESSMENT OF
WATER NEEDSClient: Pennsylvania Gas and Water Company

A comprehensive investigation of the existing and projected water needs for more than 450,000 residents of the metropolitan Wilkes-Barre-Scranton, Pennsylvania area was performed. This assessment was used to formulate a long range water supply plan. The environmental impact of withdrawing 110 million gallons per day from the Susquehanna River was assessed as well as various methods of securing additional water sources.

002986

SURFACE HYDROLOGY

COMPUTER MODEL
OF A WATERSHEDClient: Minnehaha Creek Watershed District

On the basis of data collected from a network of hydrologic instruments established throughout the watershed, as well as from historical data, E. A. Hickok and Associates developed a digital computer mathematical model for Minnehaha Creek, which is the major tributary to the Mississippi River within the Twin Cities Metropolitan Area. The model has nine sub-systems, and 315 variable parameters that represent soil characteristics, areas, evaporation rates, evapo-transpiration rates, seepage, etc. In response to input of daily precipitation data from ten sample years, the model will determine correlative lake levels and stream flows throughout the District.

SPECIAL FLOOD
HAZARD STUDYClient: U.S. Army Corps of Engineers

A special flood hazard study was performed on the Minnesota River in the vicinity of Mankato, Minnesota. This study defined the limits of the standard project flood and the intermediate regional flood with and without a flood control project. The report defined certain responsibilities of the local units of government which were necessary to successfully implement the entire project.

FLOOD PLAIN
DELINEATIONClients: Minnehaha Creek Watershed District
Rice Creek Watershed District

The 100-year flood plain limits along selected portions of both of these metropolitan streams have been defined as a tool in the implementation of certain water management strategies. Both of these Districts are experiencing rapid urban development and increased incidences and awareness of the flooding potential. The flood plain delineation has been an important factor in the control, management and acquisition of land which are of utmost importance to each District.

TECHNICAL EXPERTISE

TYPICAL PROJECTS

SURFACE WATER MANAGEMENT PLAN

Client: City of Orono

A comprehensive surface water management plan for the entire city was developed through field surveys and computer simulation to preserve and enhance the natural drainage and treatment systems. The plan included specific recommendations for 110 marsh/wetland areas within 21 drainage basins to preserve water quality and prevent flood damages.

FLOOD INSURANCE STUDIES

Client: The Federal Insurance Administration
(Housing and Urban Development)

Flood Insurance Studies are being performed for 18 communities within the State of Minnesota. These studies include reconnaissance, survey of the communities, hydrology of the study area, use of the HEC-2 model to determine the flood plain area, preparation of floodway maps and final flood insurance maps. These studies include a complete evaluation of the flood-prone areas within the community or county under study, and the results are reconciled with other on-going studies in surrounding communities.

002988

WASTEWATER TREATMENT FACILITIES

WASTEWATER POND
SEEPAGE EVALUATION

Client: Minnesota Department of Natural Resources

The wastewater treatment facility for Itasca State Park was evaluated to determine the impact of seepage from the pond system on the water resources of the Mississippi headwaters area. This study evaluated the groundwater and surface water quality by performing water and nutrient balances for the system. Intensive groundwater sampling and level monitoring programs were used along with climatological data, bacteriological and chemical water quality information to define the operating regimes in the system.

STABILIZATION POND
SEEPAGE IMPACTS

Client: Minnesota Pollution Control Agency

The study evaluated the impact of seepage from wastewater stabilization pond systems on groundwater and surface water quality. Existing systems, which characterized the general geomorphic regions of the state were evaluated. The effectiveness of the seal, the effects of the bottom deposits and the significance of the underlying soils were determined and evaluated. Complete water and nutrient balances were developed for each system. Intensive groundwater sampling and level monitoring programs were implemented, climatological data was collected and bacteriological and chemical water quality monitoring programs were established to define the variables of each system.

SOIL RENOVATION
OF WASTEWATER

Client: City of Balsam Lake, Wisconsin

This comprehensive hydrological evaluation of a proposed wastewater adsorption system considered a variety of factors including groundwater flow, quality and fluctuations, permeability and adsorptive capacity of the soils systems, impact of wetlands on effluent quality and groundwater quality and effects of soils on the nitrogen, phosphorus and heavy metals concentrations. This evaluation permitted approval of a system based on several recommended design modifications.

LAND APPLICATION OF
TREATED WASTEWATERClient: City of Storm Lake, Iowa

A comprehensive investigation was conducted in order to determine the feasibility of land application of treated wastewater in the Storm Lake area. The project was unique in that the wastewater application treatment was designed for maximum crop production and resource utilization. The application treatment was based on the results of a statistical analysis of plant available soil moisture data.

002990

LAKE RESTORATION PROJECTS

LAKE MONITORING
PROGRAM

Client: Minnesota Pollution Control Agency

perhaps the most intensive lake sampling program ever accomplished anywhere was undertaken on Lake Minnetonka, the number one recreational lake in Minnesota. Approximately 5,000 water quality samples were collected and analyzed during one year from a network of sampling stations covering the lake.

LAKE RESTORATION

Clients: Rice Creek Watershed District
Minnehaha Creek Watershed District
Minneapolis Park and Recreation Board
Clearwater River Watershed District

A number of feasibility studies for lake restoration projects have been performed. These projects include water quality sampling, analyses and evaluation, determination of pollutant sources, determination of alternative corrective actions, cost effective analysis of the alternatives and environmental assessment of the alternatives. Application for grant funds have been prepared and follow-up correspondence processed.

A project developed for the Long Lake Chain of Lakes at an estimated cost of 2.6 million dollars was awarded an Environmental Protection Agency lake restoration grant. This three year restorative project includes sediment control and removal, flood storage and routing, wetland treatment and erosion and nutrient control measures.

A lake restoration system for Wirth Lake in the City of Minneapolis was designed and constructed, which included aeration and biological activated soil filtration.

LAKE PHALEN
RESTORATION
EVALUATIONClient: Ramsey County, Minnesota

In order to determine the most effective restoration measure that should be implemented, this evaluation considered detention ponding, reuse of urban runoff, seepage ponds, first flush diversion systems, biologically activated soil filtration units and lake level management technique. The evaluation included a detailed investigation of the lake's interconnection with the groundwater system and the role of the lake's sediments as a nutrient load. Several multipurpose measures are recommended based on projected improvements on the water quality of the intensively used urban lake. These measures include providing for recreational activities improved habitat areas, a stabilized lake level in addition to an improved aesthetic quality.

SMALL BOAT HARBOR

Client: Corps of Engineers, St. Paul District

Configuration channel and dredging alternatives were evaluated for the Warroad small boat harbor in Lake of the Woods. This project evaluated the sediment deposition patterns in the harbor, considered various channel configurations, considered construction alternatives to provide a channel and evaluated the maintenance requirements for the various configurations. A unique solution was developed which minimizes the channel maintenance requirements.

EVALUATION OF
HIGHLAND LAKE
RESTORATION PROJECTClient: Hennepin County

An intensive water quality monitoring program is being implemented to evaluate the results of a lake restoration project performed on an urban lake in Hennepin County. Evaluation is to determine the effectiveness of the lake restorative techniques employed on the lake and include water quality sampling of the lake as well as the influent streams and drainage systems.

STORMWATER MANAGEMENT

STORMWATER
TREATMENT FACILITYClient: Dayton-Hudson Properties, Inc.

This project received a Grand Award for engineering excellence from the Minnesota Association of Consulting Engineers in February, 1976. The project was designed to maintain the ecological balance of a lake receiving runoff from a new major regional shopping center in a suburban setting. The facility was designed to meet the stringent requirements of a NPDES permit, one of the few issued to heretofore sources considered to be non-point. The facilities, consisting of multiple baffled grit and floating debris removal units, holding ponds, oil removal units and outlet controls, are capable of handling a 100-year return frequency storm.

MUNICIPAL STORMWATER
TREATMENT NEEDSClient: Minnesota Pollution Control Agency

The municipal stormwater treatment needs for the entire State of Minnesota were developed by the firm. The variables considered include city type, land use, precipitation, topography, soil type, population area, existing development patterns, pollutants generated, effluent standards and receiving water standards. The overall needs for both stormwater collection or separation and treatment for more than 440 cities were determined with populations from 505 to more than 430,000. Typical treatment facilities were described as well as construction and operational procedures and expenses.

STORMWATER TREATMENT
SYSTEMClient: Twin Cities Metropolitan Airports
Commission

A complex drainage network serving an international airport requires stormwater treatment and control facilities to comply with the conditions of the National Pollutant Discharge Elimination System permits. The drainage is contributed by lands under the jurisdiction of a variety of agencies and lands on which to construct facilities are also controlled by outside sources. The coordination of the concerns of the many agencies involved, coupled with the technical complexities of problems make implementation of these projects extremely sensitive. The projects include water quality monitoring, flow measurement, preliminary design, permit acquisition, final design and construction of the required facilities.

002993

**EVALUATION OF
STORMWATER TREATMENT
METHODS****Client: Minnehaha Creek Watershed District**

An Environmental Protection Agency research and demonstration project to evaluate various techniques of controlling, managing and treating urban stormwater runoff was performed by the firm. Techniques evaluated include porous roughing filters, filtration by natural marshes, high rate pressure filtration and organic soil filtration. The hydrologic, nutrient and microbiological aspects of the various techniques were evaluated. Recommended methods of treatment and design criteria have resulted from the project.

002994

TECHNICAL EXPERTISE

TYPICAL PROJECTS

WATER RESOURCES INVESTIGATION

MINE WASTE FACILITY

Client: AMAX Exploration, Inc.

This investigation assessed the complex hydrological systems of northeastern Minnesota relative to providing a dependable makeup water supply for a major mining facility. The study included evaluation of several alternatives and combination of supplies, compatibility with tailings disposal facilities, other water users, regulatory requirements and anticipated environmental impacts. A complete review and analysis of existing data was performed in the area of climatology, geology, groundwater, soils, stream flow, runoff water use, other disposal facilities, and capital, operation and maintenance costs. Statistical techniques were used to develop correlations and projections of "wet" and "dry" year conditions. The conclusions drawn from this study are used to plan the ultimate facilities with a projected useful life of at least forty years.

TAILINGS DISPOSAL SITE SELECTION

Client: Reserve Mining Company

In order to assist the Reserve Mining Company in the selection of an environmentally acceptable tailings disposal site, a comprehensive geo-hydrologic investigation was conducted in northeastern Minnesota. The analysis included water balance determinations, surface and subsurface geology, surface and subsurface hydrology and also an assessment of potential environmental impacts.

PRE-OPERATIONAL WATER QUALITY MONITORING

Client: International Nickel Company

An intensive water quality and limnological investigation was designed, performed and completed over an eighteen month period to define background conditions in Northeastern Minnesota prior to commencement of the construction of a copper-nickel mine. In addition to the standard water quality parameters, trace metal analysis to parts per billion and parts per trillion sensitivity were performed. Hydrologic analysis, groundwater evaluation, analysis of stream and lake sediments, installation of a remote gauging station and evaluation of bottom organisms were other specific items in the investigation. The most advanced sampling, sampling handling and analytical techniques including flameless atomic spectrophotometry were routinely used.

002995

AIRPORT SERVICES

NATIONAL RUNWAY
FRICTION MEASUREMENT
PROGRAMClient: Federal Aviation Administration

The runways at more than 270 of the major airports throughout the United States are being evaluated for the pavement conditions and the friction characteristics. This 24-month project includes the design, procurement and operation of six sophisticated friction measurement vehicles. The techniques include the use of the Mu-Meter and a qualitative and quantitative evaluation of such pavement characteristics as texture, construction method, rubber accumulation, surface contaminants on the pavement, structural condition, joint condition and other miscellaneous parameters. A sophisticated data base management computer program has been developed and all data is input from the field, to an on-line computer system. The objectives of this massive data collection system are to increase the effectiveness of the funding program and to enhance safety by reducing hydroplaning and improving runway friction characteristics.

RESERVOIRS AND DAMS

HOLLISTER DAM

Client: Pennsylvania Gas and Water Company

The firm was retained in an intensive study of an existing earth-fill dam measuring 1,200 feet in length and approximately 60 feet in height with an ogee side spillway. The study was to determine the causes of excessive seepage and boiling conditions which developed after construction and remedial measures necessary to ensure safe conditions. The study included an analysis of groundwater conditions, grout curtain, clay core, internal stress-strain measurements and foundation and embankment soils. The results of study indicated that severe piping conditions had occurred resulting in full penetration through the clay core.

TECHNICAL EXPERTISE PERSONNEL

EUGENE A.
HICKOK, P.E.
President

A graduate of both the University of Minnesota and Princeton University where he obtained a Master of Science degree in geological engineering, Eugene A. Hickok has headed his own firm of consulting hydrologists since 1961. Previously, he served as a staff hydrologist with International Development Service, Inc. in Guatemala; as a partner in the firm of Geraghty, Miller & Hickok, Consulting Hydrologists, New York, New York; and as a groundwater geologist with Leggette, Brashears and Graham, Consulting Groundwater Geologists, also of New York.

Mr. Hickok is a Registered Professional Engineer in Minnesota and nine other states. He has served as President of the Tech Board of the University of Minnesota School of Engineering and is a member of the Minnesota Association of Consulting Engineers, International Association of Hydrologists, American Institute of Professional Geologists and the American Water Works Association. He is a member of the American Society of Civil Engineers and serves on the Watershed Management Committee and the Executive Committee for Underground Liquid Waste Disposal.

He also has served on the Consulting Council of the University of Minnesota Water Research Center and as a member of the Governor's Water Law Review Committee, the Minneapolis City Council Water and Sewer Coordinating Committee and on the Water Resources Coordinating Committee of the Minnesota Society of Professional Engineers.

JOHN R.
MACLENNAN, P.E.
Executive
Vice President

Mr. MacLennan is a University of Minnesota graduate with a Bachelor of Science degree in Mining Engineering and a minor in Business Administration. He is a Registered Professional Engineer in Minnesota and Pennsylvania.

He has developed computer programs to determine the hydrologic balance of developing watersheds, predict urban runoff quantities, predict dissolved oxygen, pollutant levels and flow in streams and to route storm flows through detention basins.

Prior to his association with E. A. Hickok and Associates, Mr. MacLennan was with Honeywell as senior staff engineer, Director of Engineering, and Product Manager. He also was with the Chief Consolidated Mining Company in Utah and the E. J. Longyear Company in Pennsylvania.

002998

TECHNICAL EXPERTISE PERSONNEL

Among other activities, Mr. MacLennan has engaged in the construction of well irrigation systems in Florida and development of mineral resources in Central America. While in Los Angeles, he was a member of the West Basin Water Council and Vice President for Industrial Development of the Gardena Chamber of Commerce. He serves as a Director of the Water Research Foundation, a member of the Board of Managers for the Nine Mile Creek Watershed District, and was a founding Director of the Minnesota Association of Watershed Districts.

NORMAN C.
WENCK, P.E.
Vice President

Mr. Wenck obtained a Master of Science degree in Civil Engineering at Iowa State University. Mr. Wenck has been in charge of a wide range of water supply, transmission, storage and water treatment projects in the United States as well as overseas. He has research and development work in the water treatment field, and has had extensive experience in storm and sanitary sewer design, sanitary landfill design, site development, engineering and feasibility studies and site engineering and drainage. He is a Registered Professional Engineer in Minnesota, Wisconsin, Iowa and Pennsylvania.

Mr. Wenck has managed projects of state, regional and national scope, including solid waste design and evaluation studies, waste load allocation studies, hazardous waste evaluations, lake restoration projects, EPA research projects and basin water quality management plans. He has planned major data collection and interpretation efforts and has planned and designed several significant stormwater treatment facilities.

He has authored several professional papers on stormwater treatment, wetlands research, land application of wastewater and instrumentation of test roads.

GEORGE W.
BOYER, P.E.
Vice President

Mr. Boyer graduated from the University of North Dakota with a Bachelor of Science and a Master of Science degrees in Civil Engineering. He taught at the University of North Dakota and was resident engineer on an Idaho missile base before heading the civil engineering department for a major consulting engineering firm. Mr. Boyer designed more than thirty major projects, including water and wastewater treatment plants. Mr. Boyer is a Registered Professional Engineer in Minnesota, Pennsylvania, Iowa and Wisconsin and a member of several professional organizations.

002999

TECHNICAL EXPERTISE PERSONNEL

Mr. Boyer is an experienced designer of water supply, water treatment, waste treatment and general civil and municipal projects. He is an experienced specifications writer and construction contract administrator. Mr. Boyer has extensive experience estimating construction costs and developing practical solutions to difficult problems.

DR. DANIEL J.
KNUTH

Dr. Daniel J. Knuth graduated from Mankato State College in 1967 with a Bachelor of Arts degree, obtained his Master of Arts degree in Physical Geography in 1970 and his Ph.D. in Physical Geography with minors in Geology and Cartography in 1975 from Indiana University. Dr. Knuth has held responsible positions with the Minnesota Department of Natural Resources and the Minnesota Pollution Control Agency as principal hydrologist. He has designed, conducted and supervised surface and groundwater hydrologic studies, performed load allocation studies and developed and used mathematical models for hydrologic and water quality studies. He has prepared water management plans, developed rules, policy and procedural recommendations for state-wide permit programs. Dr. Knuth taught at Macalaster College for two years and has published and presented 20 technical papers. He has provided legal testimony in several landmark cases and served on several community and professional committees including the International Joint Commission.

JOHN B.
ERDMANN, P.E.

John B. Erdmann was graduated from Harvard College with a degree in Engineering and Applied Physics. Mr. Erdmann has developed and used computer programs for stream and estuary water quality simulation, data storage, reduction and retrieval systems and stream load allocation analysis. He authored the Charles River Basin Plan (303) in Massachusetts and has conducted research on reaeration rates and time of travel in streams as well as water quality surveys of streams, lakes and coastal waters. His background in the ecological, planning and research aspects of water pollution control is a valuable part of the inter-disciplinary approach of the firm. Mr. Erdmann has performed evaluations of sanitary landfill, evaluations of hazardous wastes problems and site evaluation, facilities design and groundwater modeling related to hazardous wastes. He is experienced in lake restoration techniques and evaluation procedures. Mr. Erdmann has published several professional papers on water quality mathematical modeling techniques.

003000

TECHNICAL EXPERTISE PERSONNEL

TIMOTHY M.
RING, P.E.

Timothy M. Ring is a graduate of the University of Minnesota with a Bachelor of Civil Engineering and a Master of Science degree in Civil Engineering. He is a Registered Professional Engineer in Minnesota.

Mr. Ring's professional experience includes deep tunnel hydraulic research at Saint Anthony Falls Hydraulic Laboratory and teaching fluid mechanics research at the University of Minnesota. He has performed flood plain studies using the HEC-2 model and is project manager for 18 flood insurance studies for the National Flood Insurance Program. He has experience with groundwater hydrology and investigation projects throughout the Upper Midwest.

W. FREDRICK
RIDDLE

W. Frederick Riddle graduated from Iowa State University with a Bachelor of Science degree in Electrical Engineering and with a Master of Science degree in Civil Engineering. Mr. Riddle has hands-on experience with the HEC-2, HEC-1 and TR-20 models for flood plain and hydrology analyses. He is proficient in computer programming and has an excellent working knowledge of computer system hardware including control system basics and microprocessor/microcomputer technology. Mr. Riddle has experience with the hydrology, hydraulics, modeling and systems analysis aspects of flood plain analysis. He has evaluated flood control reservoirs in Iowa and has presented papers on mathematical modeling and vegetative impacts in fluctuating pool reservoirs.

WILLIAM D.
WEIDENBACHER, P.E.

William D. Weidenbacher is a graduate of Iowa State University with a Bachelor of Science degree in Civil Engineering. He is a Registered Professional Engineer in Minnesota and Iowa. Mr. Weidenbacher has had extensive experience in construction management in the fields of land development and building construction. As Vice President and Land Development Manager for the Jonathan Development Corporation, he was responsible for all planning, design and construction operations in the new town of Jonathan. Other experience includes Street and Drainage Engineer for the City of Bloomington and Production Manager for Pentom, Inc. Mr. Weidenbacher is a member of the American Society of Civil Engineers and also active in the Minnesota Society of Professional Engineers. He has extensive experience with watershed management projects as well as Federal and State regulatory and grant administration procedures.

003001

TECHNICAL EXPERTISE PERSONNEL

JOHN A.
HOLMQUIST, AIPG

John A. Holmquist received his degree in Geological Engineering at the University of Minnesota. Mr. Holmquist has had broad experience in engineering and mineral geophysics in the United States and Central America. He has conducted geophysical research and exploration for the Phelps-Dodge Corporation in Montana, South Dakota and Wyoming, and has been in charge of geological engineering investigations and geological studies for the Materials and Research Section of the Minnesota Highway Department; the Bureau of Engineering, Minnesota Department of Conservation; and the City of Minneapolis. He is active in the American Institute of Mining Engineers and is a Registered professional Geologist. Mr. Holmquist is an experienced manager of watersheds and water quality and is an expert in dealing with regulatory agencies.

HARRY L.
SUMMITT, P.E.

Harry L. Summitt is a graduate of Iowa State University with a Bachelor of Science degree in Civil Engineering and is a Registered Professional Engineer in Minnesota. Mr. Summitt has been in responsible charge of engineering projects including infiltration/inflow analyses, sewer system evaluation surveys, facilities planning, area-wide waste treatment management plans and combined sewer overflow studies. He has managed projects relative to work effort, budget, timing and the technical effort required. Mr. Summitt's broad project experience provides important project management input to the team.

MICHAEL A. PANZER

Michael A. Panzer has earned a Bachelors degree with Distinction in Geological Engineering from the University of Minnesota. His major interests are in geo-mechanics with strong background in Civil Engineering and Geology. Mr. Panzer has performed municipal planning, design and surveys including street design, construction staking and inspection, soils analysis and quantity estimating. He is presently performing water resources planning including hydrologic analyses of interrelated watershed units, surface runoff storage and treatment analyses and evaluation of environmental impacts of proposed land developments on the water resources of a major metropolitan watershed.

003002

TECHNICAL EXPERTISE PERSONNEL

STEPHEN D. PETTIT

Stephen D. Pettit graduated from Mankato State University in 1973 with a Bachelor of Science degree in Earth Science and Geography. Mr. Pettit has performed field reconnaissance surveys for more than 100 communities in Minnesota and North Dakota for flood insurance studies. He has collected all available information relating to flooding problems, hydrologic data, development plans, storm sewer plans, hydraulic structure and crossings. He has performed the hydrologic analyses required for flood insurance studies and has prepared final study reports. His capabilities in the area of planning, land-use analysis, data acquisition, cartography, geology and hydrology make him a valuable member of the study team.

STEVEN J. ALBRECHT

Steven J. Albrecht is a graduate of the University of Minnesota with a Bachelor of Science degree in Microbiology and Zoology. He is Director of the analytical laboratory, with experience in atomic absorption spectroscopy and darkfield microscopy. He serves on several laboratory quality control committees and professional committees. Mr. Albrecht is experienced in lake evaluation and lake restoration procedures and funding procedures.

BETSY A. HANNUM

Betsy A. Hannum graduated from Lawrence University in Appleton, Wisconsin with a Bachelor of Arts degree in Chemistry and Biology. Miss Hannum's responsibilities include analysis of water, soil and minerals, development and standardization of laboratory techniques and evaluation of analytical data. She has developed and implemented rigid quality control procedures for the analytical laboratory work. Her experience and background as a biologist are valuable to the limnological evaluation of lakes, ponds and wetlands.

ELIZABETH J. JOHNSON

Elizabeth J. Johnson has been in charge of microbiological studies and analysis for an Environmental Protection Agency research and demonstration project to evaluate the effectiveness of wetlands and marshes to control and improve the quality of stormwater runoff. Miss Johnson received her Bachelor of Science degree in Microbiology from the University of Minnesota. She has extensive experience with FITC staining techniques and darkfield microscopy related to physical and chemical changes in the wetlands environment. She has performed several projects evaluating the impacts of wastewater ponds on local water resources. Miss Johnson has computer programming experience using a large data base management system.

003003

TECHNICAL EXPERTISE PERSONNEL

WAYNE A.
FRETHEIM

Wayne A. Fretheim has provided landscape architecture support for a variety of projects including recreational projects on Minnehaha Creek, a natural environment park in the Meadowbrook Lake area, a park in the City of Orono, the landscaping for stormwater facilities in a Metropolitan State Park and various projects for the Hennepin County Park Reserve District. Mr. Fretheim is a graduate from Iowa State University with a Bachelor of Science degree in Landscape Architecture. In addition to providing the design team with landscape architecture, he has experience with design and evaluation of stormwater control and treatment facilities including sedimentation ponds and filtration facilities. He has performed inventories of terrestrial vegetation and wildlife for several environmentally sensitive areas.

LARRY L.
JOHNSON

Larry L. Johnson was graduated from Kansas State University with a Bachelor of Science degree in Geology and from the University of Alaska with a Master of Science degree in Science Management. Mr. Johnson has diverse experience including teaching meteorology, performing clay mineral research, highway and building construction inspection, materials testing and geological drafting. Mr. Johnson has performed numerous groundwater projects monitoring and evaluating the impacts of landfills and seepage ponds. Mr. Johnson is an experienced geophysical specialist, having planned and directed seismic field work, interpreted seismic surveys, performed geological, geophysical and bathymetrical mapping. Mr. Johnson spent several years with an oil company performing geophysical studies in Alaska. He is experienced with the water resources and environmental aspects of projects since there has been close coordination of these factors required for these sensitive projects.

PAUL D.
JOSEPHSON

Paul D. Josephson graduated with a Bachelor of Science and Master of Science in Agricultural Engineering from the University of Minnesota. In addition to experience at Hickok and Associates on the National Runway Friction Measurement Program, Mr. Josephson has been an instructor at the University of Minnesota, teaching engineering, surveying and testing procedures. Mr. Josephson also has two years of experience managing the University of Minnesota Tile Testing and Research Laboratory. Mr. Josephson's experience in teaching, working with testing procedures and laboratory work is a valuable asset to the problem solving projects he is now associated with.

TECHNICAL EXPERTISE PERSONNEL

PETER R.
WILLENBRING

Mr. Willenbring graduated from the University of Minnesota with a Bachelor of Science degree in Civil Engineering. His professional experience includes municipal engineering with the City of Richfield and surveillance and enforcement activities with the United States Environmental Protection Agency. Mr. Willenbring has performed effluent sampling inspections, worked with spills of oil and hazardous materials, reviewed spill prevention control and countermeasure plans and prepared technical reports of the field investigations. He has experience with water resources management techniques and is familiar with regulatory agency procedures.

GREG E. SAUNDERS

Greg E. Saunders is a graduate of the University of Minnesota with a Bachelor of Science in Civil Engineering. Mr. Saunders has two years of materials testing, research and evaluation experience in the University research labs, including materials evaluation for pavements and other construction materials. He has experience with the evaluation of runway pavements and the gathering of runway friction information.

DALE M. BRINTNALL

Dale M. Brintnall has a Bachelor of Science degree in Mathematics from the University of Minnesota and has five years of experience as an electrical technician. He has experience with the interpretation of data as well as with the maintenance and calibration of technical equipment.

CLIFF D. REEP

Cliff D. Reep has a Bachelor of Science degree from the University of Minnesota in Environmental Design. Mr. Reep's professional experience includes civil engineering design with the U. S. Army Corps of Engineers and residential construction experience.

STEVEN L. MONSON

Steven L. Monson has a Bachelor of Science in Earth Sciences from St. Cloud State University. Mr. Monson's professional experience includes field investigation and survey experience with the South Dakota Geological Survey performing, coordinating and classifying materials and data collection.

003005

TECHNICAL EXPERTISE PERSONNEL

DORIS C. MINNERATH

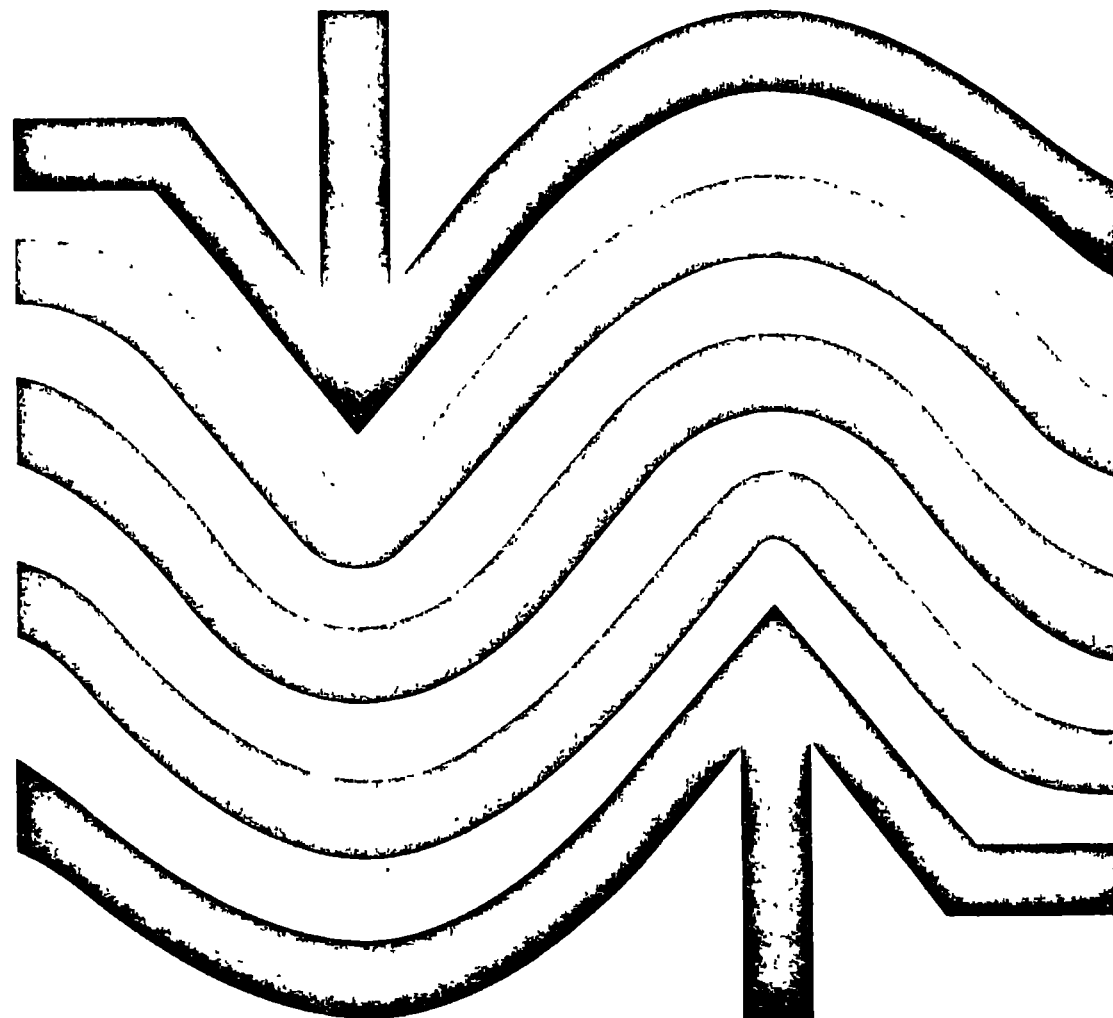
Doris C. Minnerath has a Bachelor of Science degree in Earth Sciences from St. Cloud State University. She has experience in highway and pavement design and construction for over 10 years as part of a contractor's organization. she has experience with pavement materials and pavement construction techniques.

003006

Eugene A. Hickok AND ASSOCIATES

Consulting Hydrologists-Engineers

545 Indian Mound, Wayzata, Minnesota 55391



003007

EUGENE A. HICKOK AND ASSOCIATES

Consulting Hydrologists-Engineers

545 Indian Mound

Wayzata, Minnesota 55391

**PROFESSIONAL INVESTIGATIONS
RESOURCES AND SERVICES**

Water Resources Planning

Environmental Assessments

Hazardous and Solid Waste Studies

Airport Studies and Data Management

Groundwater Exploration, Development and Management

Site Engineering

Municipal and Industrial Water and Wastewater Treatment

Lake Restoration, Limnological and Water Quality Surveys

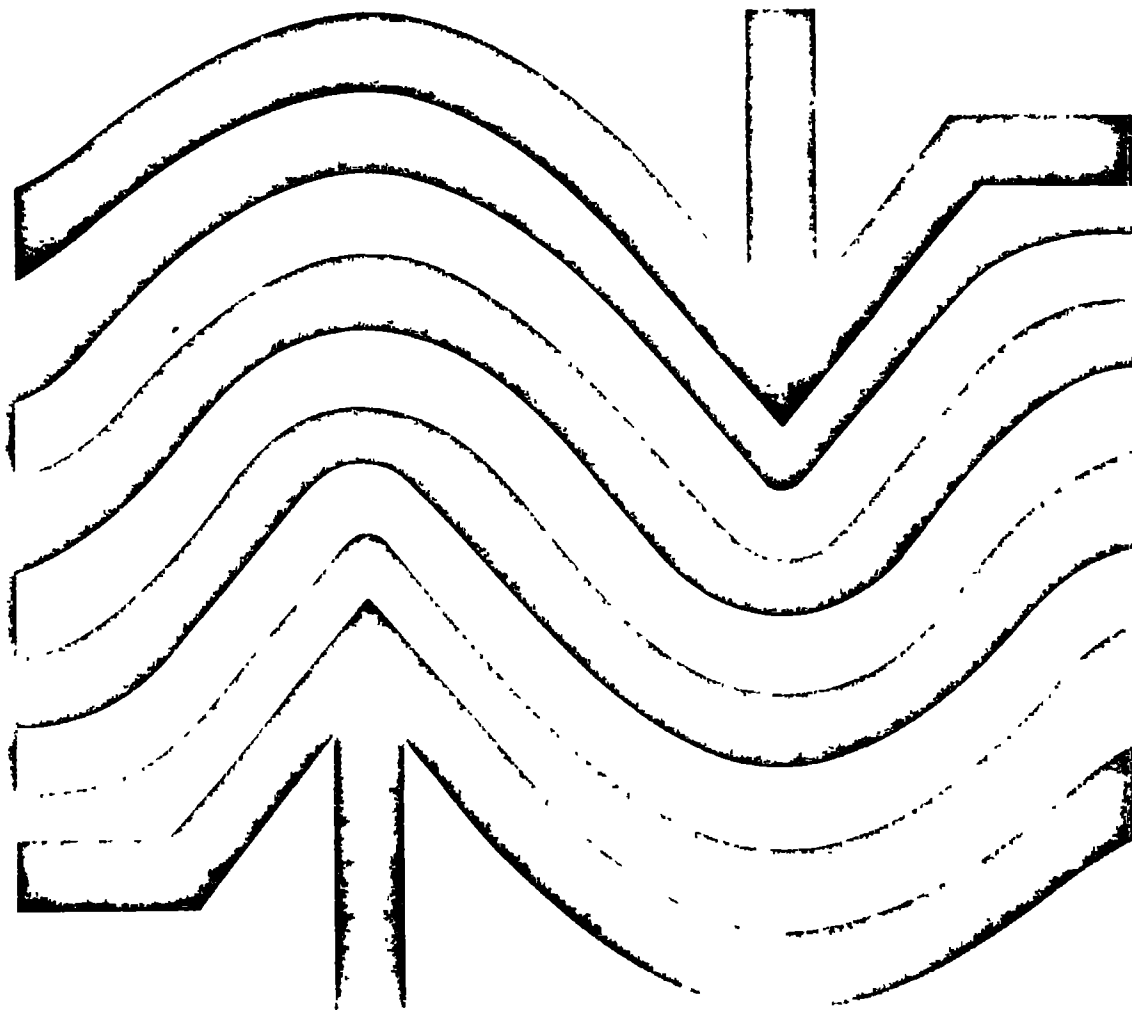
Geological, Geophysical and Mineral Investigations

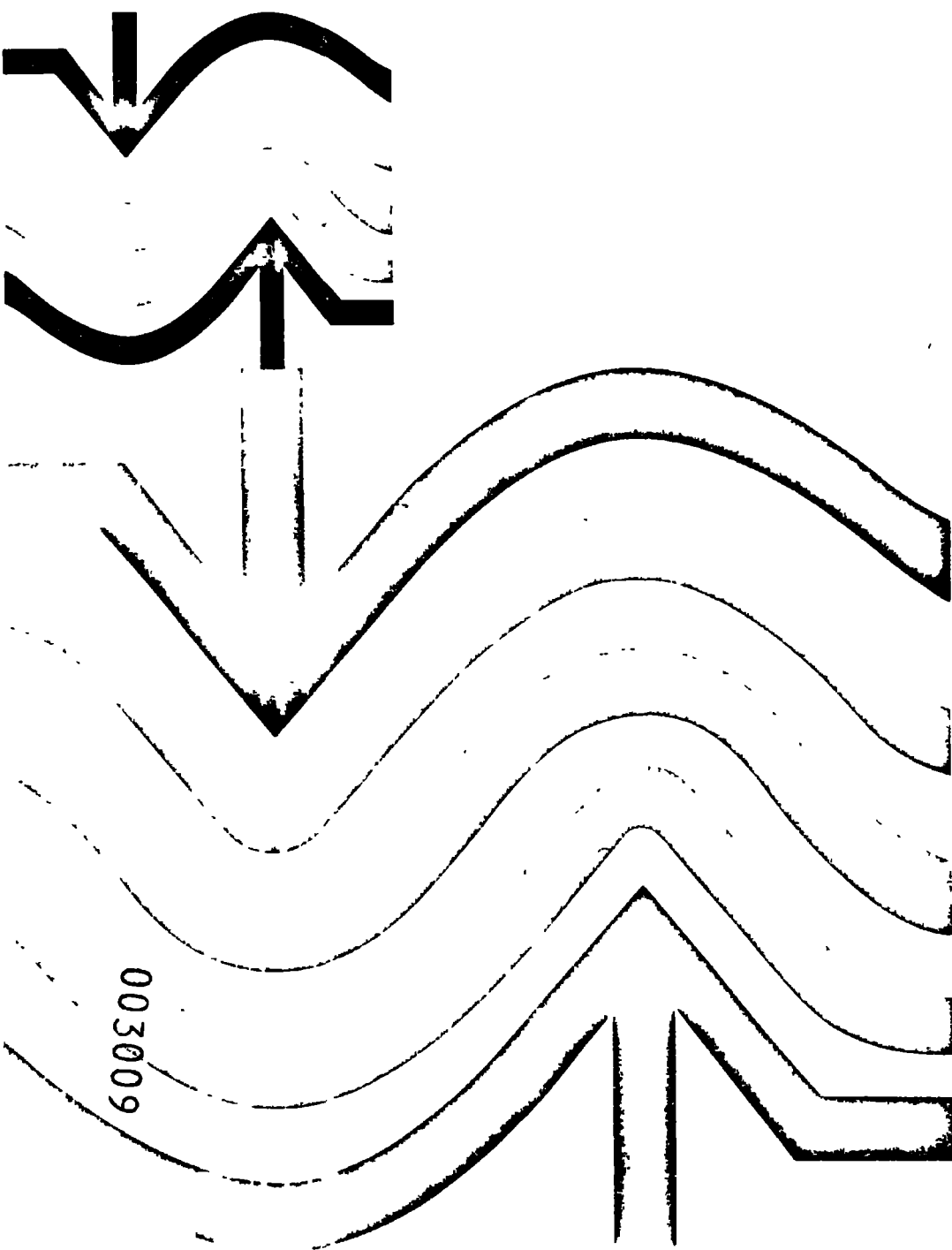
Groundwater Contamination Studies

Floodplain and Stormwater Management

Certified Testing of Water, Air, Soils and Minerals

800
644
8000





EUGENE A. HICKOK AND ASSOCIATES, long one of the midwest's leading consulting engineering firms in the fields of water resources and hydrology, is rapidly gaining national recognition in these and other diverse fields. A dedicated, professional staff enables the firm to offer complete problem-solving services. From identification of the problem, through evaluation, planning, design and implementation of the solution, it is known for its ability to produce results in accordance with budgets and schedules.

The firm has a broad interdisciplinary staff of professionals in the fields of hydrology, geology, civil and sanitary engineering, chemistry, microbiology, environmental science and landscape architecture with extensive computer application capabilities

It also has a full line of surveying, geophysical (seismic and resistivity), water and soil sampling and testing equipment plus ten computer terminals. In addition, it operates a complete water quality and microbiological laboratory specializing in trace metal analysis and advanced microbiological staining techniques.

The company has provided professional water quality services to the World Health Organization, the Pan-American Health Organization and many different federal, state and local governments and agencies. And it has had extensive experience with water supply, water treatment and both water and solid waste disposal problems associated with paper, power, mining, food processing, chemical manufacturing, heavy equipment manufacturing and the oil, aviation and brewing industries.

Eugene A. Hickok & Associates utilizes the strong project management approach whereby each manager is responsible for his own scheduling and budgeting. The entire professional staff is then available to him for technical assistance. This enables each client to benefit from the varied training, experience and talent of the many specialists in the Hickok organization.

PARTNERS OF THE FIRM



EUGENE A. HICKOK



JOHN R. MacLENNAN



NORMAN C. WENCK



GEORGE W. BOYER

EUGENE A. HICKOK

A graduate of the University of Minnesota and of Princeton University where he obtained a Master of Science degree in Geological Engineering, Eugene A. Hickok has headed his own firm of consulting hydrologists and engineers since 1961. Previously, he served as a staff hydrologist with International Development Service, Inc. in Guatemala; as a partner in the firm of Geraghty, Miller and Hickok, Consulting Hydrologists, New York, N.Y., and as a ground water geologist with Leggette, Brashears and Graham, Consulting Ground Water Geologists, also of New York.

Mr. Hickok is a registered engineer in Minnesota and nine other states and has directed water supply investigations and water development projects throughout Central America, Mexico, Panama and many islands of the Caribbean.

He has been a member of the Governor's Water Law Review Committee, the Minneapolis City Council Water and Sewer Coordinating Committee and the Consulting Council of the University of Minnesota Water Research Center. He also has served as president of the Tech Board of the University of Minnesota School of Engineering and is a member of the Consulting Engineers Council of Minnesota, the International Association of Hydrologists, American Institute of Professional Geologists and the American Water Works Association.

JOHN R. MacLENNAN

As Executive Vice President of Eugene A. Hickok and Associates, Mr. MacLennan has worked on a variety of water management programs throughout the country. He is a registered professional engineer in Minnesota and Pennsylvania and has developed computer programs to evaluate airport runway characteristics, to determine the hydrological balance of developing watershed districts and to predict both urban runoff quantities and dissolved oxygen, pollutant levels and flow in streams.

Prior to his association with Eugene A. Hickok and Associates, Mr. MacLennan was with Honeywell as senior staff engineer of the Data Systems Division and Director of Engineering at the Gardena, California, plant. He also was with the Chief Consolidated Mining Co. in Utah and the E. J. Longyear Co. in Pennsylvania.

A graduate of the University of Minnesota with a Bachelor of Science degree in Mining Engineering and a minor in Business Administration, Mr. MacLennan serves as a director of the Water Research Foundation and was a founding director of the Minnesota Association of Watershed Districts. He also has conducted flood insurance studies and has authored papers on control of urban erosion, waste load allocation and stormwater treatment.

NORMAN C. WENCK

A graduate of Iowa State University where he obtained a Master of Science degree in Civil Engineering, Mr. Wenck is a registered engineer in Minnesota and other states. He has been in charge of a wide range of water supply, transmission, storage and treatment projects in the United States, as well as overseas. He also has had extensive experience in stormwater and wastewater studies, engineering and design.

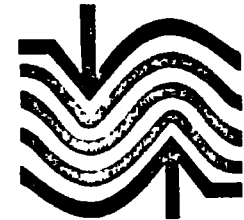
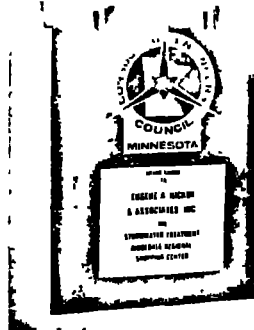
Mr. Wenck has managed projects of state, regional and national scope including waste load allocation studies, hazardous waste evaluations, lake restoration projects, EPA research projects and basin water quality management plans. He also is the author of professional papers on stormwater treatment, wetlands research, land application of wastewater and instrumentation of test pavements and airport runways.

GEORGE W. BOYER

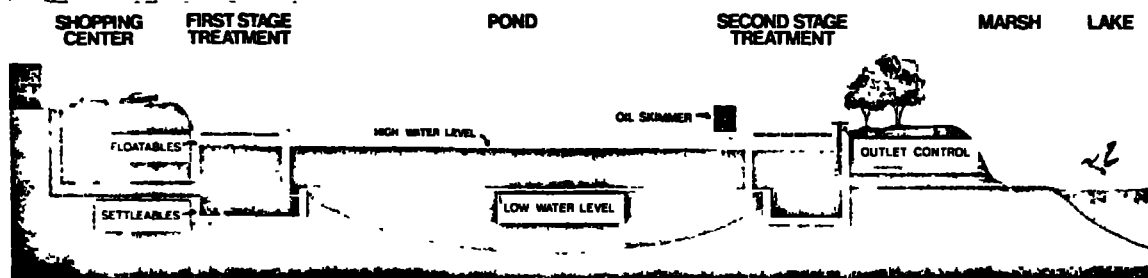
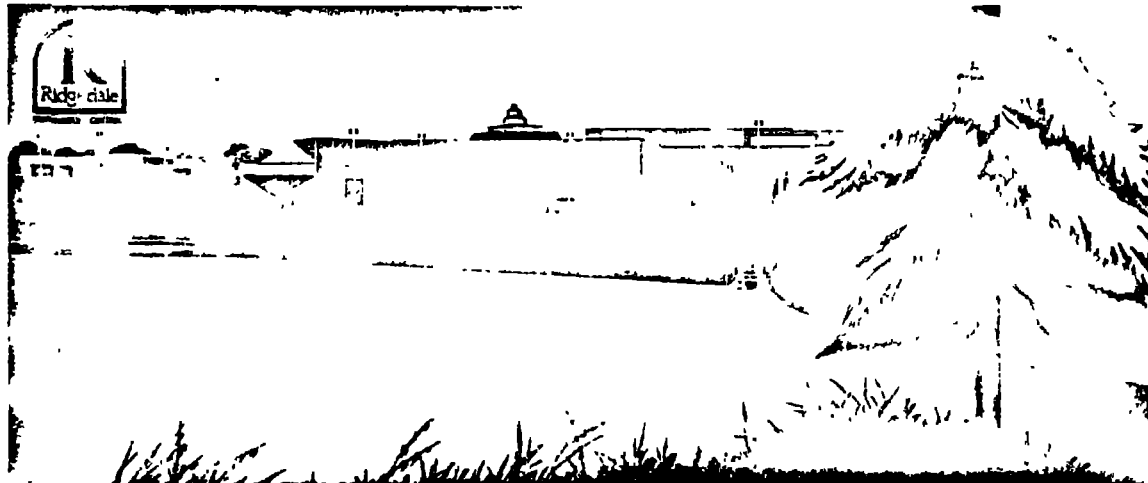
The designer of more than thirty major projects including water and wastewater treatment plants, Mr. Boyer is a graduate of the University of North Dakota with a Master of Science degree in Civil Engineering. He also taught at the University of North Dakota and was both a design and resident engineer before heading the civil engineering department of a major consulting engineering firm.

Mr. Boyer also is a registered engineer in Minnesota and several other states and has designed water supply, water treatment, waste treatment and general civil and municipal projects. An experienced specification writer and construction contract administrator, he is known for his ability to develop practical solutions to difficult problems and to keep construction projects on schedule and within budget.

This project received a Grand Award for Engineering Excellence from the Minnesota Association of Consulting Engineers. Innovative technology, uniqueness of the project and adherence to sound engineering principles were the criteria upon which the award was based.



Stormwater treatment facility



client:
DAYTON-HUDSON PROPERTIES, INC.

problem:
To maintain the ecological balance of a lake receiving runoff from a major new regional shopping center in a suburban setting. An estimated 70,000 pounds of suspended solids and 9,000 pounds of oil, in addition to nutrients and other materials, must be removed from this runoff annually to maintain the quality of the lake water.

solution:
Two stormwater holding ponds with a capacity of 42-acre feet were designed and included in the original grading plan. Treatment facilities include multiple baffled grit and floating debris removal units, oil removal units and inlet and outlet controls. This treatment system meets the stringent water quality requirements of an NPDES permit and is capable of handling a 100-year frequency storm.

OBJECTIVE

To maintain the natural aesthetic and environmental integrity of 120 acres of lake and marsh downstream of 85-acre regional shopping center development.

RESULTS

No changes in ecological character of lake and marsh can be observed or measured. More than 80,000 lbs. of suspended solids removed from stormwater runoff in first season. Although subjected to severe spills, no visible oil has been carried to lake and marsh.

003011

Regional water studies

client:

MINNEHAHA CREEK WATERSHED DISTRICT

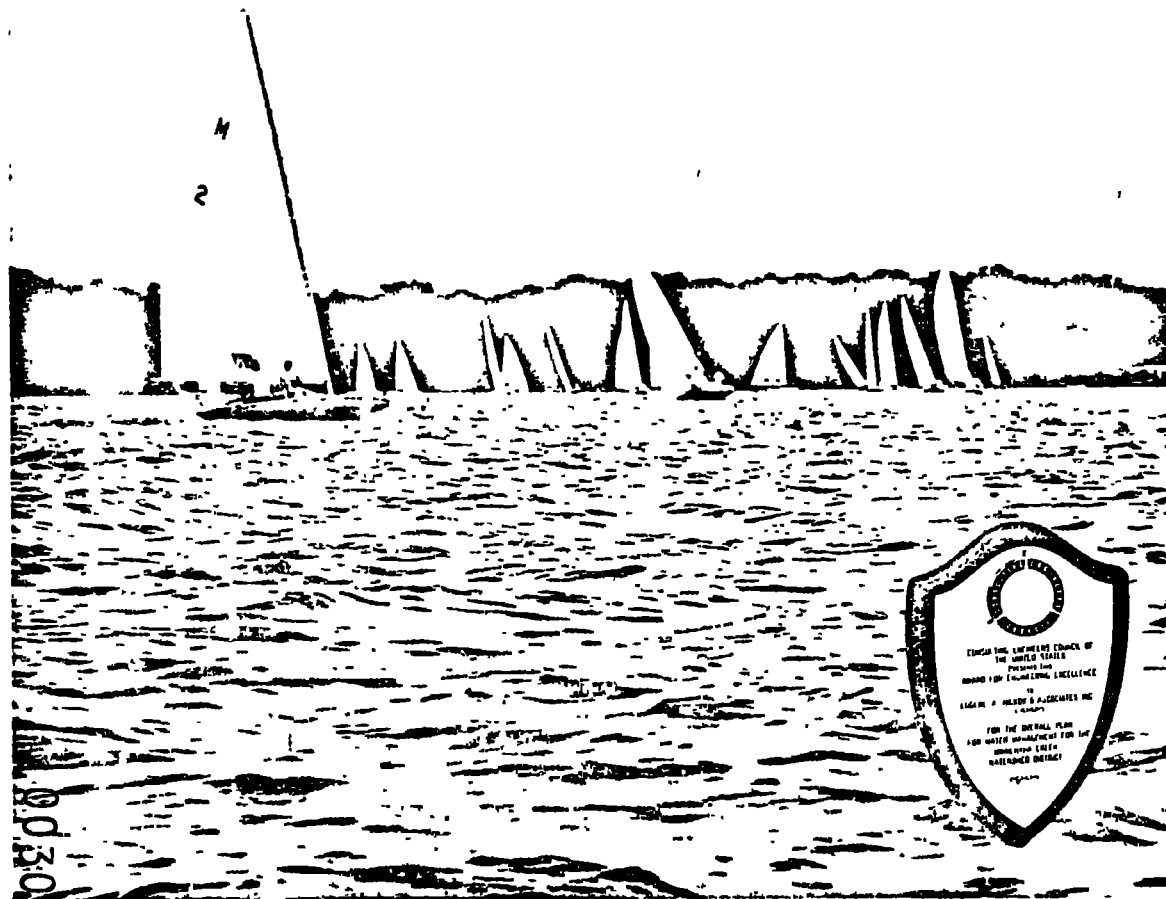
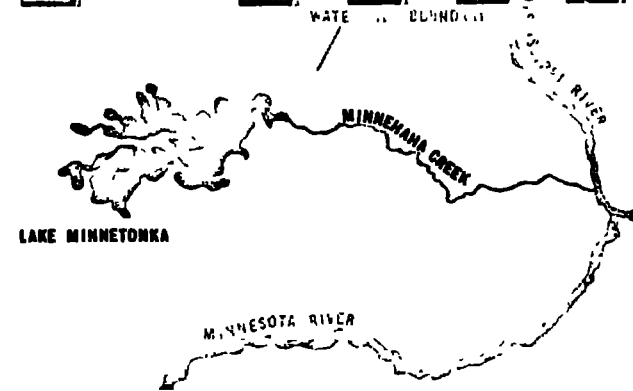
problem:

To develop an overall plan for the purpose of implementing a land, soil and water management program in a district comprising 174 square miles and including both urban and rural areas. Present and future population densities and land-use requirements were major factors which had to be considered in the development of this plan.

solution:

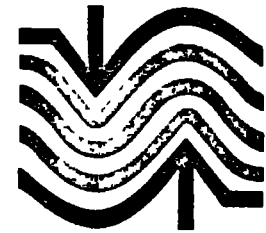
There are 33 units of government within the Watershed District: 27 municipalities, 4 townships and 2 counties. Development of the plan included a comprehensive investigation of local regulations, the philosophy of the citizens and the natural and historical characteristics of the communities. The natural characteristics of the watershed, its historical significance, population and economic growth patterns and the quality of its water resources were major areas of investigation. Problems were defined and plans and recommendations presented to the Board of Managers of the Watershed District. Water and land management regulations and policies also were proposed. The overall plan has now been approved by the Minnesota Water Resources Board and is being used as the management guideline for future investigations and projects within the district.

The overall plan received an engineering excellence award from the Minnesota Association of Consulting Engineers and the Consulting Engineers Council of the United States.



003012

Millions of people throughout the world are dependent upon ground-water resources for their daily water supplies. And the problem of matching the demands of our growing population with available water is one that calls for considerable expertise both in ground-water exploration and in the management of existing water facilities. Eugene A. Hickok and Associates has supplied the necessary expertise for the development of scores of public and private water supply systems. And whether the problem is one of locating a new water supply, drilling and testing a new well or finding ways in which to increase the production of existing wells, the firm is always ready to be of service.



Municipal water supply

client:

CITY OF WORTHINGTON, MINNESOTA

problem:

To find and develop sources of ground-water for a city whose future growth was threatened by an inadequate water supply. As a part of the immediate problem, the construction of a large food processing plant was being delayed until a reliable water supply could be assured.

solution:

Electrical resistivity studies were made of large areas in and around the city. Quantitative hydrologic tests provided a dependable source of water 7 miles from the city. Subsequently, production wells were drilled, a pipeline constructed and treatment facilities provided. The availability of an adequate water supply has been an important factor in the continued growth of the community.

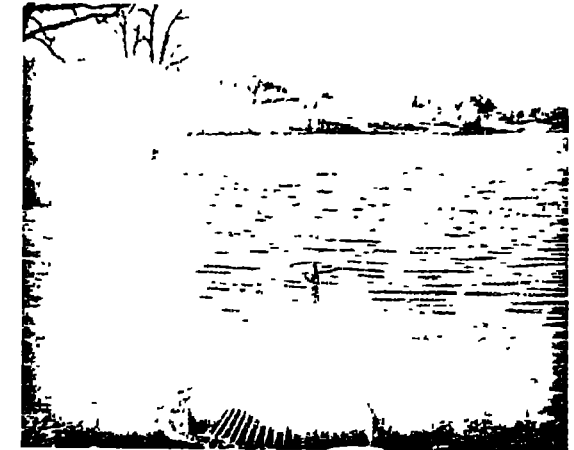


003013

Site investigations / typical project



003014



client:
JONATHAN

problem:
Development of a recreational lake for a planned NEW TOWN of 50,000 population at Chaska, Minn.

solution:
A hydrological investigation was made to determine the characteristics of an existing stream. Test drilling was conducted to determine subsurface conditions. From this data, the boundaries of the lake were planned and the site for the dam was selected. The resulting 70-acre lake provides the focal point for the planned community.

Other Activities

BASIN AND REGIONAL WATER QUALITY PLANS have been developed for state regulatory agencies, regional and local planning agencies and special-purpose districts. These plans have included long-range development goals and guidelines, stream load allocations, wastewater treatment needs, costs and priorities and all phases of water usage.

WATER TREATMENT SYSTEMS have been designed by the firm for the removal of turbidity, iron and manganese and for softening water supplies of municipalities and private industries.

WASTE DISPOSAL AND UTILIZATION systems, including conventional wastewater treatment systems and those utilizing land application techniques, activated sludge treatment of municipal wastewater, tailings disposal basins, sanitary landfills and wastewater systems with high industrial loads, have been designed by the firm. Environmentally acceptable solid waste disposal plans also have been prepared. Many of these systems required our expertise in areas of geology, hydrology and soils, as well as sanitary engineering.

FLOODPLAIN STUDIES conducted by us have identified the flood hazard zones and floodplains of numerous rivers and streams and have provided the basis for planning and flood insurance studies.

AIRPORT STUDIES AND DATA MANAGEMENT comprise another area in which we have developed considerable expertise. Presently, we are conducting a national runway friction measurement program which represents the first systematic effort to evaluate runway surface conditions on approximately 500 runways at 270 airports serving turbo-jet aircraft. This program will develop a data base and statistical analysis which will help insure the design and maintenance of safer pavement surfaces at U.S. airports.

STORMWATER TREATMENT FACILITIES for shopping centers, airports and other major point sources of pollution have been designed to comply with the requirements of regulatory agencies. Control and management of stormwater runoff is an important environmental aspect of any new facility or development.

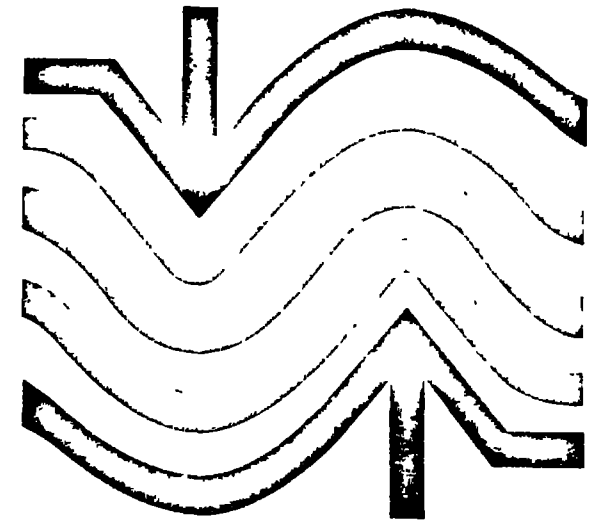
GROUNDWATER CONTAMINATION is an increasingly critical problem in both urban and industrial areas. We have conducted investigations to determine contamination sources, movement patterns and flow rates. These studies have resulted in the incorporation of appropriate abatement facilities and practices.

LIMNOLOGICAL STUDIES have been conducted to quantify the nutrient and hydrologic balance for lake systems. Management guidelines also have been prepared to assist governing bodies in improving the quality of their water resources.

ENVIRONMENTAL ASSESSMENTS and impact studies have been prepared to evaluate the effect of projects or plans on the total environment. These studies have involved quantification of the action as well as cost/benefit analysis.

COMPUTER PROGRAMS have been designed and developed for financial planning, stormwater runoff impact and hydrological studies. Stream load allocation studies have been performed on eight river segments in Minnesota. The firm currently operates one of the largest data base collection and analysis systems in the country.

A TESTING LABORATORY is operated to provide complete analysis of water, wastewater, air, soils and minerals. Water quality monitoring programs have been established for many governmental clients to measure chemical and biological factors and determine the impact of pollution sources.



Some of the Clients the Firm Has Served . . .

INDUSTRIAL

Apple River Chemical Company
Dairyland Power Cooperative
John Deere & Company
Eagle-Picher Industries
Glenwood-Inglewood Co.
Green Giant Company
Honeymead Company
International Nickel Company
International Minerals and Chemical Company
Kimberly-Clark Corporation
Kraft Foods
3M Company
Munsingwear
Northern States Power Company
Oliver Iron Mining Company
E. J. Longyear Company
Northwestern Malt & Grain Company
Wausau Paper Mills Company
Morton Salt Company
Amarada Hess Oil Company

MUNICIPALITIES

Chisholm, Minn.
Eau Claire, Wisc.
Glenwood, Minn.
Hibbing, Minn.
Jackson, Minn.
Luverne, Minn.
Mankato, Minn.
Marshall, Minn.
Mitchell, S.D.
New Ulm, Minn.
Olivia, Minn.
Storm Lake, Iowa
St. Louis Park, Minn.

Sleepy Eye, Minn.
Stevens Point, Wisc.
Wayzata, Minn.
White Bear Lake, Minn.
Willmar, Minn.
Worthington, Minn.

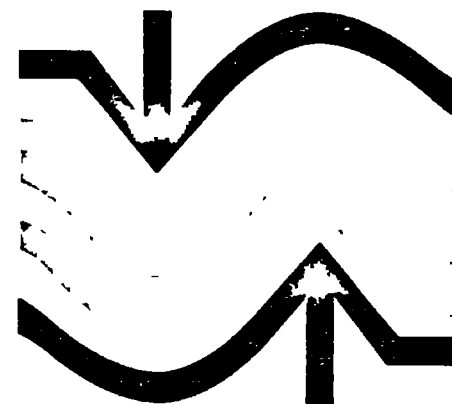
OTHER PUBLIC AGENCIES

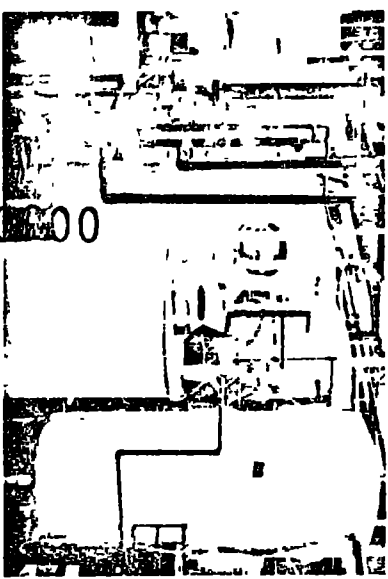
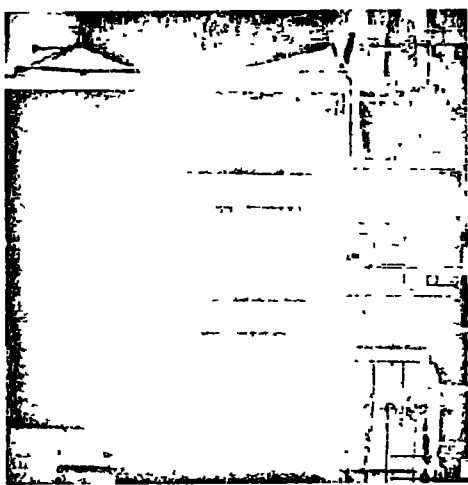
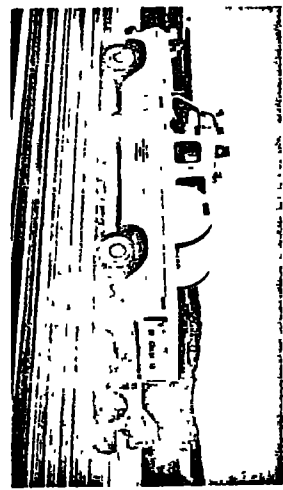
Metropolitan Council
Minnehaha Creek Watershed District
Minnesota Department of Natural Resources
Minnesota Highway Department
Minnesota State Planning Agency
Pan American Health Organization
Minnesota Pollution Control Agency
World Health Organization
Buford-Trenton Irrigation District
Rice Creek Watershed District
Iowa Department of Environmental Quality
U.S. Environmental Protection Agency
North Dakota State Water Commission
Metropolitan Airports Commission
Federal Aviation Administration
Federal Emergency Management Agency
U.S. Corps of Engineers

MISCELLANEOUS

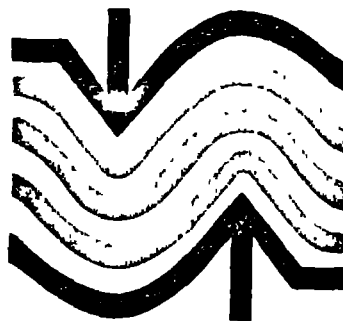
Minnegasco
Minneapolis Athletic Club
Minnetonka Country Club
Orrin Thompson Homes
Water Research Foundation
Buck Hill Ski Area
Pennsylvania Gas and Water Company

- A. Testing for ground-water pollution
- B. Sampling lake bottom sediments
- C. Airport studies and data management
- D. Testing water quality
- E. Stormwater treatment facilities
- F. Spillway construction at dam site
- G. Soils testing for artificial lake construction
- H. Water treatment installation
- I. Pulsing drill-hole with electric logger
- J. Test drilling for village water supply in Central America





000017



**EUGENE A. HICKOK
AND ASSOCIATES**

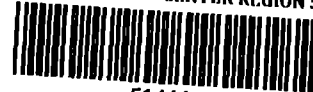
Consulting Hydrologists-Engineers

545 Indian Mound
Wayzata, Minnesota 55391
(612) 473-4224

003018

INFORMATION SUMMARY
TO ACCOMPANY REQUESTS FOR PROPOSAL FOR
CREOSOTE CONTAMINATION STUDY IN ST. LOUIS PARK

US EPA RECORDS CENTER REGION 5



514448

The area to be studied surrounds and includes the site previously occupied by Reilly Tar and Chemical Corporation's Republic Creosote Works, which engaged in the distillation of coal tar products and creosote impregnation for over 50 years, ending in 1971. As a result of the company's operation and waste disposal practices, substantial portions of the soils on and about the plant site and one or more underlying aquifers have been contaminated with coal tar wastes. The area to be studied lies in St. Louis Park, Minnesota, a suburb located directly west of Minneapolis. The Republic Creosote Works was located west of the present Louisiana Avenue extension, south of West 32nd Street, east of Pennsylvania Avenue, and north of Walker Street. The site is now owned by the St. Louis Park Housing and Redevelopment Authority and a portion has been developed as a residential complex.

location

WELLS AT SITE:

An 8-inch well drilled to a depth of approximately 900 to 1,000 feet located on the site is reported to have been severely contaminated with creosote that inadvertently flowed into the casing from a tank car spill. This well is cased to a depth of about 250 feet. The well has not been permanently abandoned but is maintained for monitoring purposes. Another well on the site was drilled in 1946 to a depth of about 100 feet and terminated in the Platteville limestone. The upper termination was completed below grade in the basement of one of the plant buildings. In 1975 this below grade well was covered by a temporary storage pond

006447

in which contaminated water was impounded. There are a number of additional wells in the vicinity which produce contaminated water. Although the total number of wells in the area that cross connect aquifers is unknown, the U.S.G.S. in 1979, submitted a report identifying all wells of record.

DEPARTMENT OF HEALTH INVOLVEMENT:

In 1932, the City drilled a 16-inch, 540 foot deep well, cased to 280 feet, to provide water for its public water supply. Several water tests showed bacterial contamination, and a disagreeable taste and odor had developed and persisted in the water. Because the water showed persistent bacterial contamination and because the State Health Department could recommend no solution to the taste and odor problem, the department recommended that the City abandon the well. This was done later in the year.

In December of 1973, the department reported that low levels of phenols had been detected in some municipal wells and in several industrial wells near the site.

In September, 1974, the department issued a "Report on Investigation of Phenol Problem in Private and Municipal Wells in St. Louis Park, Minnesota." Findings of the report indicated the following:

1. Determinable amounts (≥ 0.002 milligrams per liter) of phenolic compounds as phenol in varying concentrations and frequency were found in both private and municipal wells in the St. Louis Park area.

006448

2. Considering the reported depths of the affected wells, it is estimated that phenols can be found in well waters from

the shallower drift wells down to the Pre-cambrian Red Clastics at approximately 900 feet. Spatially, the geographical boundaries of the well sampling pattern extend over much of the St. Louis Park area.

3. Wells in this survey showing the highest concentrations and most consistent phenol levels are located close to the former Republic Creosote property,

4. Chemical analysis of soil borings^{made} south of the former Republic Creosote property indicated that at the test site a black viscous material with a strong creosote odor was found at a depth of 45 feet. Water pumped from a bore test hole in this area also showed a high phenol content at 45 feet. Cores from a depth of 67 feet have a tar-like odor.

Conclusions of the report were:

1. The analyses of the well water samples indicated the presence of a determinable amount of phenol compounds.

2. A review of the wells tested indicated that a majority of these wells contained phenol compounds.

3. From dimensional and construction data of the affected wells, it has been shown that phenols can be found in all formations of the aquifer from the drift formation down to the Pre-cambrian Red Clastics at 900 feet.

4. Consideration of the large amount of waste material discharged on the surface, the extended length of time over which discharge has occurred and the spatial arrangement of affected wells can lead to the conclusion that widespread contamination has

taken place extending perhaps to the farthest tested wells in St. Louis Park and surrounding communities.

Recommendations indicated that:

1. A comprehensive geological and hydrological study should be made to determine the effects of the previous waste disposal practices of the former Republic Creosote Company on the aquifers in the area.

2. A study to determine the feasibility of rehabilitation of the aquifers should be undertaken. If rehabilitation is not possible, a program to confine the contaminants should be considered.

3. An ongoing epidemiological study should be made to see if there are possible public health hazards resulting from the pollution of the affected aquifers.

4. A monitoring system should be established to determine if contamination is spreading with time, and if so, to determine the direction and rate of spread.

5. Contingency plans to protect the present or existing sources of ground water should be developed. Removal of contaminated materials may be necessary to alleviate the chronic source of contamination. Remedial treatment of water before use may also be necessary.

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POLLUTION CONTROL AGENCY, ROLE AND EVALUATION OF BARR REPORTS

A report prepared by the staff of the Minnesota Pollution Control Agency in November, 1977, summarized the involvement of the Agency up to that time. The report included an analysis of a report prepared by Barr Engineering Co. Inc., a consultant to the Agency.

In the fall of 1974, storm sewer project plans were submitted by the City of St. Louis Park which would serve the site and surrounding area. The Minnesota Pollution Control Agency determined that a National Pollutant Discharge Elimination System (NPDES) permit would be required. In February of 1975 a hearing on the permit was held and in April, 1975, a permit was issued. One of the hearing officer's recommendations was that a study be conducted to determine the extent and severity of pollution of underground waters. A study plan was jointly prepared by the City, the Minnesota Department of Health and the Minnesota Pollution Control Agency. The Minnesota Legislature included funds for such a study in the Minnesota Pollution Control Agency's Fiscal Year 1976-1977 appropriation. In November of 1975, the Agency contracted with Barr Engineering, of Bloomington, Minn., to conduct the study. The first phase was completed in May, 1976. The Phase II report was completed in July, 1977.

The Phase I study was to determine the amount and location of coal tar derivatives in the surficial deposits at and near the site. Fourteen soil borings (typically 60 feet deep) were analyzed every five feet in depth for phenols and benzene extractables. In general, the data indicated low levels of benzene, extractable and phenol materials in the top 10-15 feet, over most of the site. Highest concentrations of these materials

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were found to the south of the Republic Creosote works site between Walker and Lake Streets. Concentrations in these glacial soils generally increased with depth, with high concentrations as deep as 50 feet.

Eleven soil samples were analyzed using thin layer chromatography to determine the presence of polynuclear aromatic hydrocarbons (PAHs). PAH compounds were present in all 11 samples. Of particular importance were the high concentrations of PAH at 32 and 50 feet in the soil columns south of the site between Highway 7 and Lake Street. Gas chromatograph analyses were then carried out on five of the 11 samples to determine concentrations of various PAHs. The gas chromatograph data indicated detectable amounts of benz(a) pyrene and relatively large amounts of chrysene in two samples. Both of these substances are known or suspected carcinogens.

The results of the Phase I study guided the design of the final phase. The large quantities of coal tar wastes which were present at depths of 50 and 60 feet and over a relatively large area made excavation of the wastes a financially undesirable solution. The Agency then decided to concentrate its efforts on collecting data on the hydrology of the surface and bedrock aquifers and on their chemical quality. This information would be used to predict future impacts on ground water and to evaluate the feasibility of gradient control as a corrective measure.

The major emphasis of the second phase was the definition of the vertical and horizontal ground water flow through the various glacial and bedrock aquifers. Well logs and deep soil borings were analyzed in order to develop a more detailed bedrock map of the area.

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Soil samples obtained in Phase I and Phase II were physically analyzed to determine the permeability of the various glacial materials. Literature was reviewed to determine permeabilities for the bedrock aquifers. Ground water level information was collected. A ground water model for the area was then developed using the information.

In addition to the ground water movement studies, data was collected on the chemical quality of the ground water in the various aquifers. As in Phase I, the samples were analyzed for phenols and benzene extractable material. Selected samples were also analyzed for the presence of PAH compounds. This information was evaluated to get a general idea about the behavior of the various coal tar derivatives in ground water. The information was also used to test theories on how contamination has taken place and to predict future spread of contamination.

Ground water movement in the upper drift is assumed to be primarily in the vertical direction as lateral flow to the east and west is restricted by the clay layer which nearly rises to the surface. Lateral flow in the middle drift aquifer is to the south and east. In addition there is substantial vertical recharge to the lower drift aquifer. Direction of movement in the lower drift aquifer is not clear, but appears to be primarily vertical. Movement to the east appears minimal due to the thick sequence of silts which make up the lower drift to the east. If this is correct, leakage from the middle drift aquifer to the lower drift aquifer must travel vertically to the underlying Platteville Limestone.

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The upper-most bedrock unit underlying most of the study area is the Platteville Limestone. Flow in the ^{bedrock} Platteville is generally to the east toward a buried bedrock valley. As with most limestones, flow is predominately through fractures and fissures which have become solution channels.

The Platteville may be underlain by a thin formation called the Glenwood shale. The Glenwood, where present, is a confining layer between the Platteville and the St. Peter sandstone. Where present the shale layer is impermeable enough to maintain an 18 foot head difference between the Platteville and the St. Peter. The Barr report indicates that ground water movement in the St. ^{sandstone} Peter appears to be to the east. This flow, however, is greatly influenced by the bedrock valley and existing wells. City well #3, located about 3/4 mile to the north of the site, when pumping, creates a cone of depression and draws water towards it from all directions. The Terry Excavating and Midco Register wells are only cased into the Platteville and terminate in the St. Peter. This means that there is an open hole direct connection from the Platteville through the Glenwood shale to the St. Peter. During periods of non-use, these wells function as recharge points since the head is higher in the Platteville than in the St. Peter.

The second source of recharge is the ^{presence or chance of a} bedrock valley. Understanding the bedrock valley and how it affects ground water movement is an important part of the study. The Platteville is generally 33 feet thick in the study area. As a result of erosion prior to the most recent glaciation, part or all of the Platteville was removed.

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Data used in the report indicate that at least in the area of Excelsior Boulevard and Highway 100, the erosion also removed the underlying Glenwood shale. Therefore, water reaching the valley through the Platteville or (the drift) can rapidly recharge the St. Peter since there is no Glenwood ^{drift} to restrict the downward flow.

This recharge is quite extensive where the piezometric levels in the southeast are approximately 20 feet higher than levels on the eastern edge of the study area.

Recharge from the St. Peter to the underlying Prairie duChien - Jordan aquifers is limited by a series of siltstones which make up approximately the bottom one-third of the 150 foot thick St. Peter. Under existing conditions, it is estimated it would take 55 years for water to travel vertically through the siltstones. Beneath the Jordan is a series of sandstones, dolomites and shales. The next major aquifers are Mt. Simon - Hinckley sandstones. To simplify calculations only the Eau Claire formation was considered to be limiting flow from the Jordan to the Mt. Simon. Flow time through the Eau Claire is estimated at 34,000 years.

Chemical analysis of surficial ground waters indicate high concentrations of benzene extractables and PAH compounds in the

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middle drift aquifer, south of Highway 7. Detectable amounts of PAH were also found at the base of the lower drift aquifer. Previous analyses of existing wells in the area indicated the presence of phenolic compounds in various industrial and municipal wells. These wells are of varying construction and terminate in the major aquifers previously discussed.

From the hydrologic and chemical data, the following general conclusions were drawn by the technical staff of the Minnesota Pollution Control Agency:

- 1) Ground water in the glacial drift is moving both laterally out of the area and vertically into the Platteville. Water in the Platteville is moving toward the bedrock valley.
- 2) Coal tar wastes have moved from the surface downward due to water movement and the fact that they are heavier than water. High concentrations of the wastes were found 50 feet deep. These wastes have moved laterally at least 1000 feet. This information suggests that the PAH compounds are present in water reaching the Platteville over a portion of the study area.
- 3) Phenol concentrations in the drift are likely to be moving southeastward at rates of 30 to 150 feet per year. Water in the Platteville limestone is moving toward the buried valley and will take 20 to 50 years to reach the valley. Water in the drift and the Platteville are not at steady state conditions and concentrations of pollutants will continue to increase further from the site.

- 4) The buried bedrock valley southeast of the site is a recharge area to the St. Peter. Ground water reaches the valley through the drift and the Platteville. Movement out of the valley will likely be to the east.
- 5) The uncased wells in the area provide pathways for contaminated water from the drift and Platteville to reach the lower aquifers.
- 6) Data developed in this study supports earlier findings that low concentrations of phenolic compounds are present in the bedrock wells surrounding the site and at the municipal well field north of the site. Contamination of St. Peter wells south and southeast of the site can be attributed to leakage through the Glenwood ^{dale} or down uncased wells. The available information does not, however, explain the contamination of the St. Peter and Prairie duChien - Jordon wells at the municipal well field ^{north of the site} Contamination of the Mt. Simon - Hinckley well on the site and at the well field are attributed to wastes which have moved down the Hinckley well on the site.
- 7) Since the quality of the St. Peter is controlled by recharge from the drift and the Platteville, which are not at a steady state condition, it is reasonable to assume that concentrations of contaminants will increase in the St. Peter.

- 8) The coal tar wastes in the glacial drift represent a potential threat to underlying ground water aquifers due to uncased wells, flow to the bedrock valley, seepage through the Glenwood and due to the fact that down gradient industrial wells that acted as barriers are being abandoned.

Several measures to correct or control this threat were reviewed to varying degrees. These included treatment of municipal water, excavation of contaminated soils, well abandonment and gradient control wells. A preliminary investigation of additional water treatment found this to be extremely costly in comparison to gradient control. Costs to modify the existing treatment to include activated carbon absorption would be approximately \$180,000. Costs for carbon alone would run \$.34 to \$17.00 per thousand gallons or about .75 to 35 million dollars per year if the total water use of the City were treated. This treatment would, of course, not prevent the spread of contamination to wells in other areas.

Excavation of contaminated soils was investigated. This could not be a complete solution since contaminants have moved in the ground waters out of the area of contaminated soils. The depths and amount of excavation required depends upon what concentration of contamination one wishes to remove. For example, the area and depth of excavation necessary to remove soils with 10,000 milligrams per kilogram of benzene extractable material would involve approximately 200,000 cubic yards of excavation. Problems that were not investigated with regard to excavation were disposal of removed material and the

fact that several industries and Highway 7 are situated above the area to be excavated. No costs were calculated for the excavation alternatives.

Abandonment of all wells which could be potential pathways for contaminated ground water to reach the deeper aquifers is an obvious corrective measure. Several such wells are identified in the study. It is reasonable to assume that many more wells might exist and efforts should be made to locate them. It is estimated that it would cost from \$35,000 to \$52,000 to abandon the wells which have been located to date. (Since the Barr report was written many wells have been abandoned. This activity is described in detail later in this summary.)

The principal control measure investigated in the Barr report was the use of gradient control wells. The primary purpose of such a system is to control the movement of contaminated ground water such that the size of the affected area does not increase. Although a system of gradient control wells would remove some of the contaminants, gradient control should not be viewed as a method for pumping contamination out of the ground.

just stops the spreading of contamination.

Several alternatives were investigated for disposal of the contaminated ground water. These were discharge of all or part of the water to the sanitary sewer and various treatment options prior to discharge to Minnehaha Creek. The design of a treatment system would be difficult at the present time since the quality of the water to be treated is not known. After ^{gradient control} the wells are operational, a better idea of the type and cost of treatment facilities could be determined. The capital cost of hooking the wells up to the sewer was then estimated to be \$8,000.

Barr Engineering made the following recommendations for corrective action and future studies:

1. All bedrock wells constructed so as to provide pathways for ground water to move between the drift/Platteville and St. Peter and between the St. Peter or Prairie du Chien-Jordan and Mt. Simon-Hinckley aquifers should be grouted and abandoned. Highest priority should be given to locating and abandoning wells in the area bounded by Texas Avenue on the west; Minnetonka Boulevard on the north, Highway 100 on the east and Minnehaha Creek and Excelsior Boulevard on the south. Wells in this area should be located and abandoned immediately. The investigations summarized in this report indicate that these wells present potential pathways for the movement of coal-tar derivatives to the lower aquifers and, in fact, represent the only reasonable means by which ground water in the Prairie du Chien-Jordan and in the Mt. Simon-Hinckley formation could be contaminated with waste from the site of the former coal-tar distillation and wood-preserving facility.

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2. Since the abandonment of uncased wells near the site will likely result in the movement of recharge from the buried valley to the St. Louis Park municipal well field to the north, St. Louis Park wells 1, 2 and 3 should also be abandoned.
3. The potential impact of the identified high concentrations of coal-tar derivatives in the glacial drift ground water are significant enough that mitigative measures are recommended to halt the movement of these wastes. *how about litigation?*
4. The control of ground water gradients in the glacial drift ground water system is technically feasible and the system presented in this report or a similar system should be implemented. It is recommended that design of the gradient control wells begin immediately. The first step in the design will be to place the additional wells and borings needed to define the exact location of gradient control wells. The next step will be to place one or more test wells to verify the aquifer characteristics needed to complete the design. The third step will be to complete the design and construct the wells.
5. Water pumped from the gradient control wells should be discharged to the sanitary sewer, at least initially. After the more highly contaminated ground water has been removed from the glacial drift or after treatability of the waste has been better defined, it may be possible to discharge the effluent from the wells to Minnehaha Creek after appropriate treatment.

6. Bench scale and pilot scale studies should be conducted to define the treatability of the ground water using either the existing surface water treatment facility or a new treatment concept.
7. The effectiveness of the gradient control system should be monitored both in terms of the ability of the wells to capture coal-tar derivatives through the glacial drift and Platteville limestone and, if the effluent is discharged to Minnehaha Creek, the ability of the treatment facility to meet effluent limitations prior to discharge.
8. Two additional wells should be placed in the St. Peter formation beneath the area of elevated coal-tar derivative at the drift/Platteville contact to monitor the quality of water in the St. Peter. If the average concentration of the phenolics, as measured by the MBTH Method, exceeds a concentration on the order of 20 micrograms per liter, significant change will have occurred and gradient control or some other appropriate mitigative measure should be required to control movement of the wastes in the St. Peter.
9. Further information is needed regarding the effect of the trace phenolic concentrations measured in the municipal wells in St. Louis Park. It is recommended that studies be carried out to define the potential public health effect of these trace phenolics.
10. A better definition of hydrogeology is needed in the buried bedrock valley located near Highway 100 and Excelsior Boulevard. Specifically, soil borings and piezometers should be placed in the valley to define its extent and to estimate gradients and likely vertical

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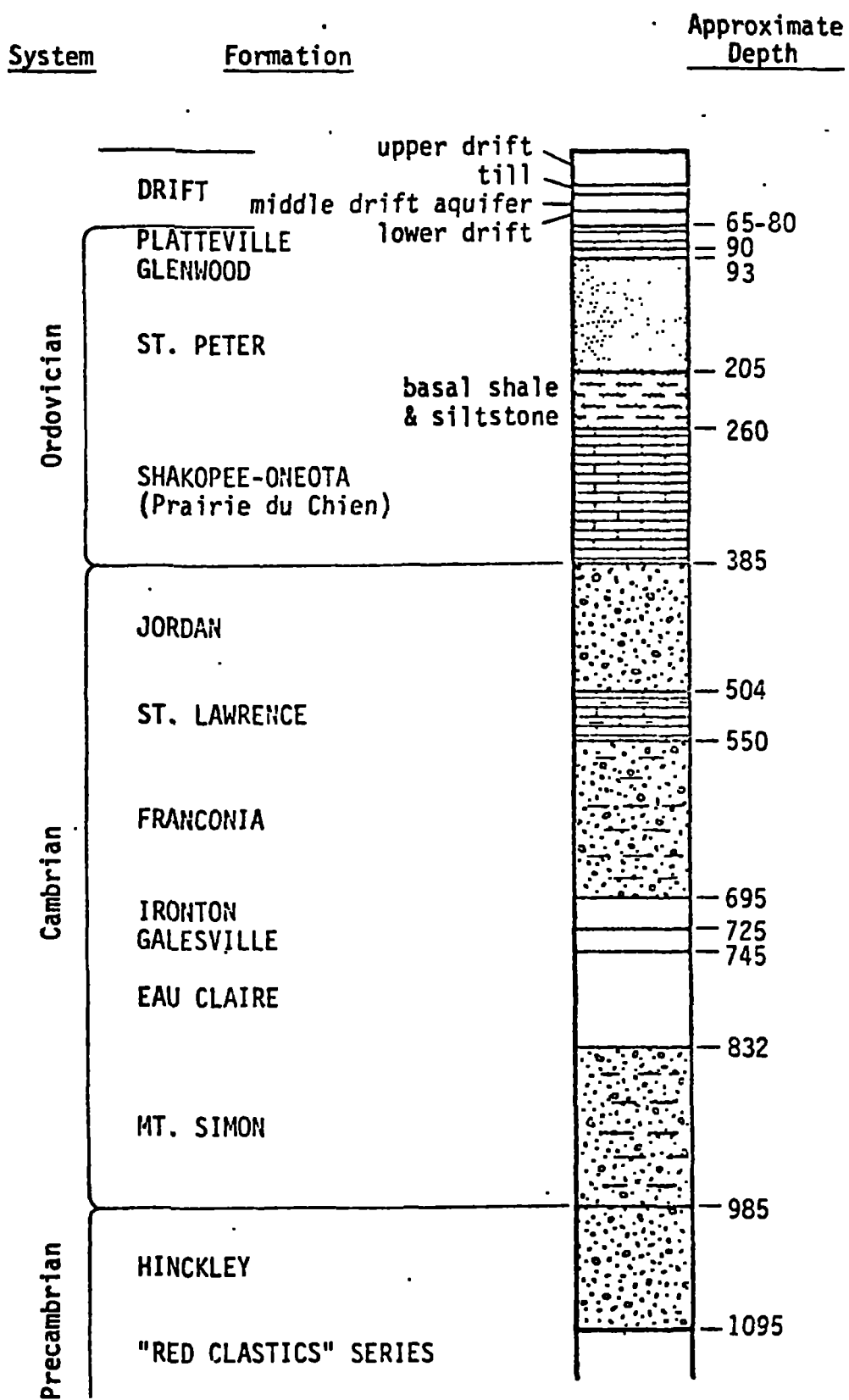
placed near the western edge of the valley to define the quality of water discharged to the valley from the site area through the glacial drift, Platteville and St. Peter units. A monitoring well should also be placed in the St. Peter north of the valley to monitor the quality of the water in the aquifer between the valley and the City well field to the north.

The staff of the Minnesota Pollution Control Agency recommended that the following steps be taken:

- 1) The Barr Engineering recommendations 1 and 2 regarding well abandonment should be carried out immediately.
- 2) The barrier well system as outlined by Barr Engineering should be designed and constructed. The design should be preceded by the studies outlined in the report . In addition, studies to determine the possible existence of a buried valley immediately south of the site which is eroded through the Glenwood shale should be conducted. The studies should commence immediately with construction as soon as design is complete.
- 3) Water pumped from the gradient control wells should be either pretreated for removal of PAH compounds prior to discharge to the sewer system or should be treated to allow discharge to Minnehaha Creek. Limited untreated discharges to the sewer system should be allowed in order to collect sufficient data for treatment plant design. 006463
- 4) Monitoring the effectiveness of the gradient control system should be conducted.

- 5) Barr Engineering's recommendation 8 with regard to the construction and operation of two wells to monitor quality of water in the St. Peter beneath the site should be implemented.
- 6) Barr Engineering's recommendation 10 for additional monitoring of the St. Peter near the bedrock valley southeast of the site, should be carried out. If the additional study in staff recommendation 2 locates a comparable valley south of the site, similar monitoring should be carried out in the St. Peter in that area.

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GENERALIZED GEOLOGIC COLUMN

WELL ABANDONMENT--MINNESOTA DEPARTMENT OF HEALTH:

STATUS OF WELL ABANDONMENT
PRIVATE WELLS
ST. LOUIS PARK

NOVEMBER 13, 1979

NON-RESPONSIVE

NON-RESPONSIVE

006467

RISK ASSESSMENT -- MINNESOTA DEPARTMENT OF HEALTH:

In October, 1977, the department released a report entitled "Assessment of Possible Health Effects Resulting from the Contamination of the Former Republic Creosote Site." In part, the report contained an assessment of the existing and potential human health risk resulting from the contamination of the Republic Creosote site based on information which was then available. The focus of concern over human exposures to creosote and coal tar wastes is the possibility that the polynuclear aromatic hydrocarbon compounds contained therein will induce cancer. A complete assessment of existing and potential health risk would require the following information, none of which is available at this time:

1. To what extent is the groundwater, and more specifically the municipal water supplies, in the area contaminated with carcinogenic PAH compounds? There are no data available on specific PAH compounds in groundwater in the area of the site.
2. What are the directions and speed of the spread of the contamination from the site? This question must be addressed for the vertical travel of the material to the deep aquifers and for the flow leaving the site area laterally. A complete treatment of this problem would also involve a determination of which fraction of

the material is actually in a water solution and which is moving as an independent phase. Also needed would be information on the position of the buried bedrock valley to the east of the site and the porosity of the material within it. Although Barr Engineering Phase II report was an in-depth treatment of certain aspects of the problem, many geohydrologic questions remain unanswered. *+ hydrogeologic*

3. What population groups are presently or potentially exposed to drinking water contaminated with PAH compounds from the site?
4. Are there significant exposures to airborne PAH compounds? Although the creosote and coal-tar are contained in the soil, the soil does not present an absolute barrier to PAH vapors.
5. Is there a potential exposure from external contact with the contaminated soil by future residential populations or to those involved in construction activities on the site?

Since this information was unavailable, the department assessment was necessarily limited. The analysis dealt only with the contamination of the drinking water supplies of St. Louis Park and Edina, Minn. The contamination of additional municipal drinking water supplies, and exposure to these contaminants in the air or by direct contact may create greater risks to the public's health than the contamination identified in the two drinking water supplies studied.

The St. Louis Park and Edina supplies have been shown to contain trace quantities of phenols, a major constituent of creosote. The presence of phenols suggests the presence of other more harmful components of creosote and coal tar such as the carcinogens benzo(a)pyrene,* benzo(a)anthracene, dibenz(a,h)anthracene, benzo(b)fluoranthene, benzo(j)fluoranthene and chrysene. Because the analytical methods in use at that time did not show any detectable concentrations of these carcinogenic PAHs, this assessment makes use of an estimated benzpyrene concentration in the water supplies of the two communities. It was assumed that the low levels of phenols which have been measured in the St. Louis Park and Edina water supplies are associated with total PAHs in the same ratio as has been measured for ground water samples collected in

*The nomenclature for the above listed compounds is the official nomenclature designated by the Intl. Union of Pure and Applied Chemistry (I.U.P.A.C.). Other more common names are often used in the literature, e.g., benzo(a)pyrene is also called 3,4-benzpyrene, benzpyrene, and abbreviated BP. In this report the more familiar common name benzpyrene or the abbreviation BP will be used.

the site area. It was also assumed that the resulting estimated total PAH values are associated with benzpyrene in the same ratios as has been found by Borneff and Kunte in samples of unpolluted European ground water. The imprecision of the assumption relating to the PAH to phenol ratio will influence the final comparison of maximum acceptable concentration vs. the estimated exposure.

Using specific well pump rates, it was calculated that the average ^{St. Louis Park} resident received a concentration of 3.66 micrograms of phenols/liter in his drinking water. A similar analysis of phenol concentrations on samples collected from the Edina system during July of 1975 show an average of 4.33 micrograms/liter.

The amount of benzpyrene associated with these phenol concentrations was estimated. The ratio of PAH to phenol for Well 17 from the Barr Phase II Report is 10.6. The ratio of benzpyrene to PAH as determined by Borneff and Kunte for unpolluted ground water is 0.01 (average of two samples). The value of 0.01 is consistent with BP/PAH ratios which have been measured for a wide variety of environmental samples as well as for creosote and coal tar in the pure state. The average estimated concentration of benzpyrene in the water supplies of the two communities can then be calculated as follows:

$$\text{BP (St. Louis Park)} = (3.66 \mu\text{g phenol/l}) (10.6 \text{ PAH/phenol}) \\ (0.01 \text{ BP/PAH}) = \underline{0.39 \mu\text{g/l}}$$

$$\text{BP (Edina)} = (4.33 \mu\text{g phenol/l}) (10.6 \text{ PAH/phenol}) \\ (0.01 \text{ BP/PAH}) = \underline{0.46 \mu\text{g/l}}$$

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A maximum acceptable level for humans of 3.1×10^{-4} ^{Benz-a-pyrene} micrograms per liter in drinking water was derived based on data obtained from animal studies.

Upon examination of the results of the calculations of the assessment, it was apparent the estimated exposure is about 1,000 times higher than the maximum acceptable exposure, suggesting the existence of a serious public health problem. Secondly, the maximum acceptable concentration is very low ($3.1 \times 10^{-4} \mu\text{g/l}$).

The health risk assessment report recommended that a number of additional studies would be necessary to quantify the extent of human exposure to carcinogenic PAH compounds in drinking water supplies of St. Louis Park and Edina.

Geohydrology studies and related environmental monitoring recommended in the assessment included the following items:

1. Further work should be done to establish the assumed ^{or absence} presence₁ of the Glenwood shale in the erosional valley immediately south of the site. Absence of the shale would provide a connection between the drift and the St. Peter allowing rapid contamination of this aquifer.
2. The piezometric head gradients, the porosity and the amount of solution channeling should be determined for the Platteville formation. An analysis should then be done of the direction and rate of flow in the ^{under} Platteville for all seasons and₁a variety of local pumping conditions. A system of monitoring wells should then be designed to establish the existing extent and future movement of contamination in the Platteville.

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3. Further work should be done to determine the possible source of the coal tar taste in old city well #1 which was apparently abandoned in 1932. This well extends into the St. Lawrence shale and is cased to the top 60 feet of the Shakopee limestone. The presence of a coal tar taste ^{the water from} in this well could possibly indicate that the Prairie du Chien-Jordon is seriously contaminated in the study area.
4. The buried bedrock valley to the east of the site should be examined to determine the presence or absence of a high permeability "pipeline" at the bottom of the valley. A pipeline at the bottom of a buried bedrock valley can provide a rapid travel path for contaminated ground water. If this condition exists in the valley east of the site it could accelerate the spreading of the coal tar wastes areally and vertically into bedrock aquifers through which the valley has cut.
5. Solubility studies should be done on coal tar wastes to determine to what extent constituents of these material are soluble in groundwater under environmental conditions. This solubility data as well as data on the desorption of these materials from soil particles are necessary to predict their future concentration and movement through the underground.

6. The source of the high concentrations of phenols in the Robinson Rubber Company well should be determined. Identification of the aquifer which is responsible for the contamination of this well would be useful in determining the directions of flow of contaminated water leaving the site.
7. Selected wells in the immediate area of the site plus all St. Louis Park and Edina municipal wells plus other, yet to be determined, downstream monitoring wells will be analyzed for trace PAH contamination quarterly for one year.

The Minnesota Department of Health health risk assessment concluded that there exists a significant potential impact on human health resulting from the contamination of the Republic Creosote site. However, future studies may indicate that no health risk exists. The following recommendations will, hopefully, provide a basis for a course of action to protect the public's health.

1. There is a need for further environmental, epidemiological, and geohydrological studies to provide the information necessary for a complete assessment of health risk and for future decisions regarding corrective measures.

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The necessity for these studies is independent of whatever mitigating measures are taken at this time since no such measures are capable of removing contamination which has left the site area.

At this time, the Minnesota Department of Health plans to attempt to conduct all the environmental monitoring and epidemiological studies during the 78-80 biennium. The scarcity of available resources may prevent sufficient progress to complete the expanded risk assessment ^{within} ^ this time period.

2. The plan for the location and abandonment of inter-connecting wells and St. Louis Park wells 1, 2, and 3, contained in the Barr Phase II Report, should be implemented with the exception of the abandonment of the Robinson Rubber Company well. This well is approximately 180 feet deep and is highly contaminated. Rather than grouting the well at this time, the well should be studied to determine which aquifer is the source of the contamination. This information will be valuable in assessing the depth which the contamination has reached. Upon completion of the study, the well should, of course, be grouted and abandoned.

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3. That a pumpout and barrier well system be designed and implemented which is capable of removing and halting a s read of contaminated water in the drift and

Platteville aquifers and any deeper aquifer which the geohydrologic studies show to be significantly contaminated. This system is more ^{extensive than} the pumpout and barrier well system recommended by the Barr report which only dealt with the drift aquifer. There is strong evidence that the Platteville is contaminated and this limestone formation may contain solution channels which could hasten the spread of not only the water soluble portion of creosote and coal tar wastes, but also the thicker fractions which are not in solution.

The effluent of the pumpout and barrier well system must receive sufficient treatment to remove a large portion of the PAH compounds contained therein. The Barr Phase II Report recommended the discharge of this effluent to the sewer. A review of the available literature indicates that conventional sewage treatment processes will be ineffective in the removal of benzpyrene and other PAH compounds. Since any discharge of this material to the sewer will eventually result in the addition of carcinogenic material to the drinking water of downstream communities, the waste should be treated to remove harmful components.

4. That if, upon completion of the geohydrologic studies there is no reasonable assurance that the waste will remain in place and will not spread, either in the ground water or as a separate non-soluble phase, either vertically to aquifers below the Platteville or laterally beyond the control of the pumpout and barrier well system, the contaminated soil (as defined in the Barr Phase II Report 1 mg/kg phenol) should be excavated from the site and disposed of in such a way as to not create a significant hazard to human health.

MINNESOTA GEOLOGICAL SURVEY -- EVALUATION OF BARR REPORT:

The Minnesota Geological Survey provided a review of the Barr Engineering report indicating that subsurface data permit several interpretations of the bedrock geologic and hydrologic conditions near the creosote site in St. Louis Park. The Minnesota Geological Survey review tends to question the hydrologic modeling and ground water gradient control wells recommended in the Barr report. Also questioned were the assumptions suggested or proposed to predict contamination migration. The Minnesota Geological Survey review is provided herewith in its entirety.



UNIVERSITY OF MINNESOTA
TWIN CITIES

Minnesota Geological Survey
1633 Eustis Street
St. Paul, Minnesota 55108
(612) 373-3372

RECEIVED

OCT 20 1977

MINN. POLLUTION
CONTROL AGENCY

October 17, 1977

RECEIVED

DEC 5 1977

Minn. Dept. of Health
Div. of Env. Health

Mr. Dale L. Wikre
Minnesota Pollution Control Agency
1935 West County Road B-2
Roseville, MN 55113

Dear Dale:

We have reviewed the Barr Engineering report entitled "Soil and Groundwater Investigation of the Coal Tar Distillation and Wood Preserving Site, St. Louis Park, MN." Upon reviewing the available geological information, we suggest that another interpretation of the bedrock topography and geology can be postulated particularly for the areas east and south-east of the site of investigations.

Our records of borings ST-1 and ST-53 located at the extension of Louisiana Avenue over the Chicago, Milwaukee, St. Paul, and Pacific Railroad tracks do not indicate the presence of the Platteville limestone as do the records of these borings shown graphically in figure 3 of the Barr report. Our copy of ST-1 indicates the Glenwood Formation was penetrated at a depth of 84 feet and the St. Peter Sandstone at 87 feet. ST-53 encountered St. Peter Sandstone at a depth of 84 feet with no Platteville but possibly some Glenwood overlying it. ST-64, a boring near these other two which is not presented in the Barr report, penetrated only St. Peter Sandstone at a depth of 98 feet. If our copies of borings ST-1, ST-53, and ST-64 are accurate, then the bedrock river channel ^{valley} southeast of the creosote site (p. III-9 and figure 7, Barr report) is cut into the St. Peter Sandstone and not just into the Glenwood Formation as postulated. We are enclosing duplicates of our copies of these borings which we obtained from the Minnesota Department of Transportation.

Additional evidence favoring a St. Peter channel southeast of the old creosote site can be obtained through another interpretation of the log for the Methodist Hospital well. The Barr report implies that since their calculated average thickness for the St. Peter Sandstone (165 feet, p. III-11) was nearly penetrated by the well (163 feet), Glenwood shale could be assumed to be present but not described (p. III-10). It is not uncommon for the St. Peter to be reported as two to four feet thicker than the Barr Engineering calculated average and so it may be possible that more than 163 feet of sandstone may have existed at the well site.

The log of a test hole for the elevator shaft at Methodist Hospital indicates that the Platteville limestone was encountered at a depth of

006478

Wikre, October 17, Page 2

60 feet. The log of the Methodist Hospital well reports penetrating St. Peter Sandstone as the first bedrock at 94 feet. If the difference in land surface elevation between the elevator shaft and the waterwell site was no more than five feet during construction of the hospital, then there would be about 29 feet of bedrock eroded between the elevator shaft and the well (94 minus 65).

Well logs about one half mile north of the hospital indicate 20 to 23 feet of Platteville remaining. Well logs in Edina about three quarters of a mile southwest of the hospital report about two to ten feet of Platteville while the record of St. Louis Park Well No. 6 about five eighths of a mile to the southeast reports about 32 feet. If well logs closest to Methodist Hospital are any indication of the thickness of remaining Platteville, then about 20 to 23 feet of Platteville should underly the site for the hospital elevator shaft and about the same amount should have been eroded at the hospital well site. This estimate would leave six to nine feet of bedrock or about three feet of Glenwood and about three to six feet of St. Peter Sandstone to be eroded in order to have St. Peter occur under 94 feet of glacial deposits at the hospital well site. Therefore, it is possible that the well log for Methodist Hospital is accurate in reporting the St. Peter Sandstone as the first bedrock and that its upper three to six feet have been eroded. This interpretation would indicate that Methodist Hospital overlies the lip of a buried river channel cut into the St. Peter Sandstone. I am enclosing copies of the geologic logs for the elevator shaft and for the waterwell at Methodist Hospital.

A bedrock geologic and topographic map based upon our copies of borings ST-1, ST-53, and ST-64 and our interpretation of the Methodist Hospital data indicates that a bedrock channel cut into the St. Peter Sandstone extends at least as far north toward the old creosote site as the extension of Louisiana Avenue over the Chicago Milwaukee, St. Paul, and Pacific Railroad tracks. We are enclosing a copy of this map. The generalized bedrock topography compiled from waterwell records and test boring logs lends support to the existence of a southeastern bedrock channel. The width of this channel cut into the St. Peter Sandstone could be approximately one city block or about as wide as the gorge cut into the St. Peter Sandstone just downstream from Minnehaha Falls. The southeast channel shown in figure 7 of the Barr report is similar in width but they interpret the bottom of this channel as lined with Glenwood shale.

Observations of channels cut through Platteville limestone such as at Minnehaha Falls do not indicate that these channels bottom in the Glenwood Formation. The Glenwood is easily eroded and especially subject to water-fall recession which is believed to have been the mechanism which formed channels cut through the Platteville in the Twin City area. Assuming a St. Peter channel is present southeast of the old creosote site, probably about 10 to 15 feet of St. Peter Sandstone has been removed at the water-fall but progressively more sandstone would have been removed by water action downstream if surface observations such as at Minnehaha Falls are an accurate analogue.

Wikre, October 17, Page 3

In addition to the southeastern channel, we suggest the channel underlying Wooddale Avenue (figure 7) is also probably cut into the St. Peter Sandstone and not just into the Glenwood Formation. Records for the abandoned St. Louis Park well at 6021 West 36th Street and for the Minnesota Rubber Company well at 3630 Wooddale Avenue each report St. Peter Sandstone as the first bedrock penetrated. The record of the Milwaukee Railroad well at Wooddale Avenue and the railroad tracks reports only four feet of limestone and shale overlying the St. Peter Sandstone and suggests the area between these three wells may mark the northern edge of a St. Peter channel whose center would lie to the southeast. We are enclosing copies of the three well logs.

The results of the hydrogeologic model in the Barr report will change if the above geologic interpolations are accepted. The buried bedrock channels southeast and east of the creosote site would create a larger recharge area for the St. Peter than depicted in the Barr Report. This situation would be especially important if valley fill deposits in the southeastern channel were permeable and hydrologically connected to the middle drift aquifer. The Platteville limestone might also discharge into the southeastern bedrock valley particularly along the Platteville-Glenwood shale contact, thereby permitting contaminants from other areas to recharge the St. Peter in addition to those directly recharging above the buried valley through the middle drift aquifer. The piezometric levels for the St. Peter in figures 18 and 19 would also be different possibly resulting in steeper gradients from the ends of the buried bedrock valleys to the city wells 1, 2, and 3. Groundwater flow lines, velocities, and travel times in the St. Peter will also change. The piezometric lines for the Prairie du Chien-Jordan aquifer in figures 20 and 21 might change, but this would have to be checked by the model. Because the presence of the two St. Peter channels will have a major impact on present hydrogeologic modeling and upon future groundwater gradient control measures, we suggest that additional test borings be placed to establish the lithology of the first bedrock at the bottom of each channel, to define channel morphology, and to determine channel hydrology.

We also have questions regarding boundary conditions established for the hydrogeologic model. The eastern and western piezometric levels of the St. Peter and the Prairie du Chien-Jordan aquifers were taken from piezometric contours illustrated in the Norvitch report (1973) as cited by Barr. The Norvitch report used 1:250,000 scale maps with 25 to 50 foot contour intervals. If the placement of these piezometric contours was not precise or if locations of those contours had shifted by the time the Barr report was initiated, then it is possible that the resultant gradients for the bedrock aquifers in the Barr report could be different. Also, on pages III-27 and III-28 of the Barr report, four wells are discarded as affecting bedrock boundary conditions. We question the assumptions and reasons used to eliminate these wells and suggest that Barr should first include these four wells and eliminate them only when the model verifies that they have a negligible affect upon defining piezometric levels in the bedrock aquifers. The model also uses aquifer

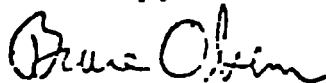
Wikre, October 17, Page 4

for the specific storage (page E-1) or the porosity (page IV-14) assigned to the Glenwood shale.

Another aspect of the Barr report which needs clarification is the assumptions used to predict contaminant migration. Barr postulates that the contaminants and the groundwater move as a single-phase flow rather than a possible multiple-phase flow system. Information regarding the solubilities of the various contaminants is necessary to investigate this, but no such information is presented in the Barr report. The contaminants could be moving at different velocities and directions than the groundwater and could possibly be trapped in areas of changing grain size creating stagnant pockets. Groundwater might continue to leach soluble parts of these trapped contaminants for longer periods than those determined by the results in figure 23. This could greatly alter the effectiveness of gradient control wells. We suggest that more information regarding the mobility of the contaminants be presented before initiating a gradient control well system.

In conclusion, the information we are presenting demonstrates that the available subsurface data permits several interpretations of the bedrock geologic and hydrologic conditions near the creosote site in St. Louis Park. Our opinion is that the bedrock channels depicted in the Barr report, and modified in our interpretation, probably cut into the St. Peter Sandstone. This interpretation of the geology would greatly add potential recharge areas to the St. Peter and could alter present hydrologic modeling. We also suggest that a re-evaluation of the data used in modeling might also alter the present interpretation of bedrock hydrology. We recommend that future remedial measures, particularly groundwater gradient controls, would be more effective if the geology and hydrology of the buried bedrock channels east and southeast of the creosote site were precisely defined.

Sincerely,



Bruce Olsen

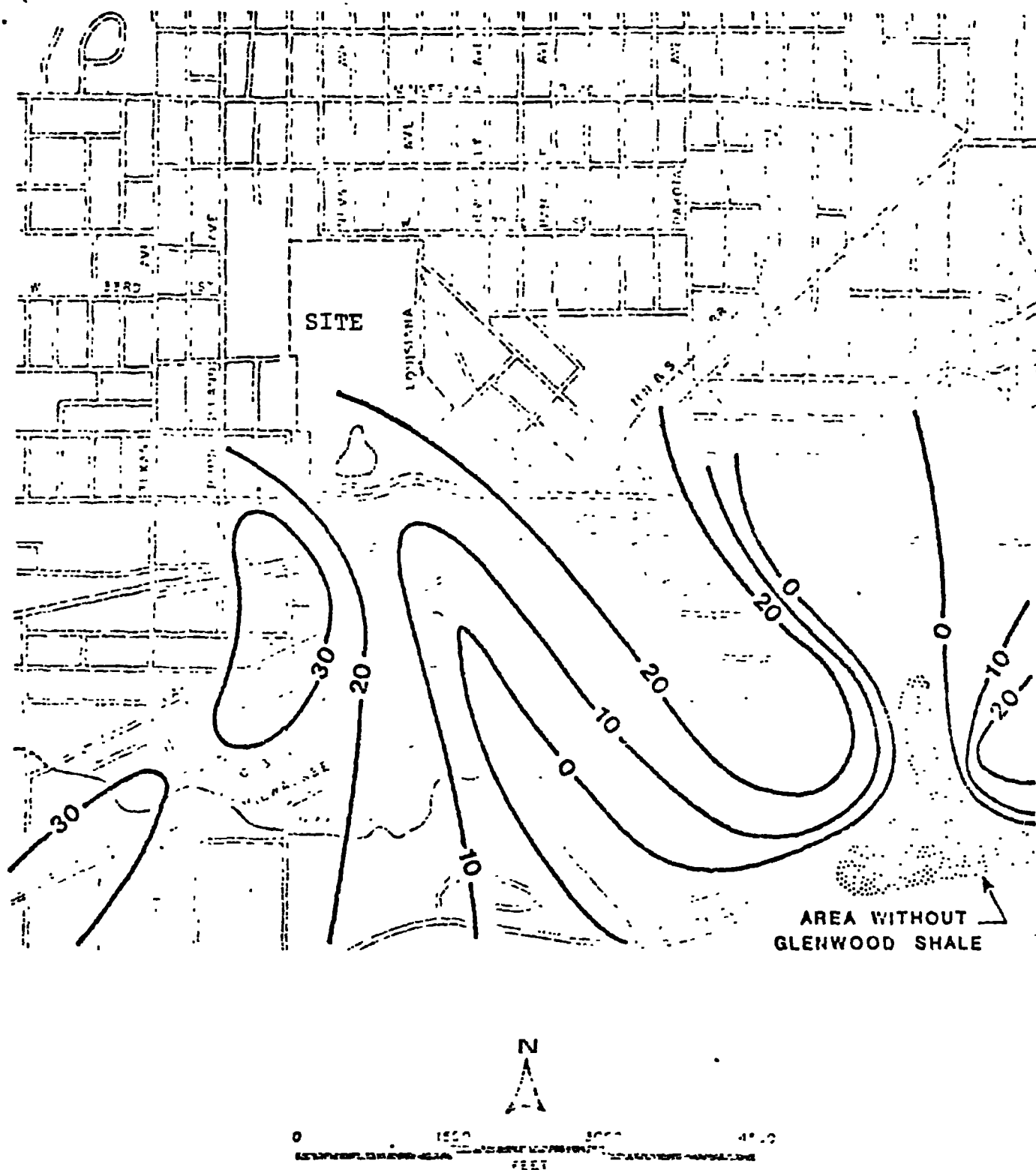


Gilbert Gabanski

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FIGURE 7 Barr Report
 THICKNESS OF THE PLATTEVILLE LIMESTONE FORMATION (FEET)
 (indicating approximate limits of buried bedrock valleys)

U.S. GEOLOGICAL SURVEY STUDY:

The U.S. Geological Survey, under contract to the Minnesota Department of Health, has been conducting a hydrological and geochemical study of the St. Louis Park area, to develop a detailed understanding of the groundwater flow system and transport of organic contaminants. The study is to be completed by June 1980. The general area of study extends three miles east and two miles south of the site. A preliminary report outlining the information gathered through June 1979 was released November 1979, containing 55 figures describing the geologic and hydrologic conditions of the study area.

Preliminary results of this report indicate that there appear to be three major sources of contamination:

- ✓ 1. infiltration of hydrocarbons spilled on site;
- ✓ 2. runoff of contaminants from the site and discharge of wastewaters into disposal ponds south of the site; and
- ✓ 3. introduction directly through the deep, multiaquifer well (909') on the site.

In addition, at least 25 ungrouted or partially cased wells exist in the vicinity of the site and these may permit contaminated water from near-surface aquifers to flow downward into deeper bedrock aquifers. Flow rates estimated by geophysical logging and inspection with downhole television cameras range from 20 to 150 gpm. Most of these wells have been logged with a downhole television camera by the Minnesota Department of Health or geophysically logged by the U.S.G.S. This information, along with drillers' logs, water level measurements, and survey reports are available from the U.S.G.S.

Dissolved constituents in the drift and the Platteville Limestone have 006483
least 4,000 feet down the hydraulic gradient (east-southeast) towards a drift-filled valley. Soil borings and well logs indicate two branches associated with the buried bedrock valley, which are ½-1 mile southeast of the site. The extent of this valley

is currently being better defined by the U.S.G.S. The valley appears to be a recharge area for the lower aquifers from the upper bedrock units.

Due to heavy and extensive groundwater utilization by municipal and industrial users, the groundwater flow systems in the Prairie du Chien aquifer are extremely complex. The distribution of contaminants is likewise complex.

The extent of contamination in the Mt. Simon-Hinckley aquifer is unknown. Contaminants have been introduced through the well on the site, so there remains a potential of further contamination spread.

The U.S.G.S. has also investigated the distribution of sodium, nitrate, ammonia, dissolved organic carbon, and total organic carbon in the Middle Drift and Platteville aquifers. Further work remains to be completed, but the current data indicate that these components are migrating to the east-southeast, with the exception of nitrates, which are decreasing (due to microbial utilization).

Studies are currently being conducted measuring dispersivity of NaCl and phenol in column packs of sand. In addition, a three-dimensional dispersivity-diffusion computer model is being developed and calibrated by the U.S.G.S. This model will be available to the consultant(s) for use.

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